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Activity Analysis of Personnel on Patient Trayline Assembly

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ACTIVITY ANALYSIS OF PERSONNEL ON PATIENT TRAYLINE ASSEMBLY

by

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A Thesis in Partial Fulfillment

of the Requirements for the Degree Master of Science

in the Field of Food Administration

January 1971

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ACKNOWLEDGMENT

The author wishes to express her sincere appreciation to:

Dr. Kathleen Zolber, Associate Professor of Nutrition, for her patient and invaluable assistance and enthusiastic encouragement, and for reading and editing this thesis.

Dr. Paul Yahiku, Assistant Professor of Biostatistics, for the generous sharing of his time and counsel in interpellation of the statistical analyses.

Miss Lydia Sonnenberg, Director of Dietary Services, and her staff for tolerance and cooperation during the data collection phases of the study.

Mr. Jere Chrispens, Scientific Computation Center, for his cooperation in computer service.

To Mr. George Cummings, Instructor in Nutrition Clinical Supervision, for his patient understanding and the time involved in the writing of the computer program, and to Mr. Ben Rockwell for his valuable assistance in writing the program.

Appreciation is expressed for financial assistance from Loma Linda University and the National Institute of Health Traineeship Grant Number AHT 70-054 (C), and computation assistance received from Loma Linda University Scientific Computation Facilities, supplemented in part FR 00276-06.

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CHAPTER I

INTRODUCTION

The systems approach in food service administration is the initial step in analyzing current procedures to determine the effectiveness of resource utilization. A system has been defined as a collection of interacting elements organized for the achievement of some objective (Gue, 1969). Analysis begins with observation of a system or event: with familiarization and thinking about the system comes the formulation of hypotheses which are possible explanations of the system behavior (McMillan and Gonzales, 1965). By carefully observing individual situations and the variables involved, by painstakingly building up records of observations, and by analyzing these data to determine if there is meaningful correlation between variables, the researcher may find new knowledge that is meaningful to science and practice (Blaker, 1967).

Hospitals must make a systematic effort to improve deployment and utilization of existing personnel, identify factors inhibiting departmental efficiencies, and explore and experiment with new patterns of work organization (Bennett, 1968).

Basic to the theory of systems is the premise that given certain inputs, the processor will yield certain output or operate within established limits. A system will include some means of control, i.e.,

a sensor for measuring output or related characteristics, a means of comparing the measurements with a standard, and an activating group to adjust inputs to correct the deficiencies (Johnson et al., 1964). The objective is to control variables so the system will tend to stabilize near the ideal equilibrium point. This objective is possible only if the operating activities can be measured.

1.1 Statement of the problem

Systematic research is a major need to fill gaps in statistical and factual information relative to health care services. Basic findings from research can be used as a guide for determining objectives and evaluating the system (Donaldson, 1965).

Hospital administrators are faced with critical decisions not known a decade ago since costs in hospitalization have shown an unprecedented increase over the last ten years. Landgraf (1967) reported that in 1966 there was a 16.5 per cent increase over the previous year. In 1954 voluntary short-term non-profit hospitals employed 207 people per 100 patients; in 1964, the ratio had risen to 247 per 100 patients. Bennett (1968) estimates that full-time equivalent jobs in the health service industry will rise from 2.7 million in 1965 to 3.1 million in 1970 and 3.6 million in 1975. This increase represents an overall percentage increase of 33 per cent from 1965 to 1975. He advises that hospitals must develop more meaningful ways to identify and alter conditions that cause inefficiency and ineffectiveness in manpower utilization and development. Since more than 60 per cent of hospital expense is payroll, there is an obvious need for an improved productivity of personnel.

A food system is composed of five basic subsystems: namely, (1) procurement, (2) production, (3) service, (4) sanitation, and (5) control (Blaker, 1967). The patient tray assembly service is one of primary importance because of the large input of both physical and human resources (McGary and Donaldson, 1969). In view of the continuing rising costs of manpower, administrators of hospital food systems must evaluate each subsystem to identify strengths and weaknesses as a basis for improving productivity. Food service costs represent approximately 10 per cent of the hospital budget. Rising costs in labor and shortages of trained personnel are a major factor in the increasing costs of dietary departments. The cost of kitchen labor alone in California hospitals rose 18 per cent in the eight-month period ending May, 1967 (Anonymous, 1968).

In view of the high cost of labor it is imperative that efficient scheduling and supervision of trayline personnel be given systematic and continual attention.

The primary objective of the hospital food service system is to provide highly nutritious, and quality food with the greatest possible efficiency at the lowest possible cost (Flynn, 1965). Reliable methods for determining the number and kinds of employees required to operate an efficient system need to be utilized by each health-care institution. The objectives for studying work activities are to increase productivity and to develop manpower effectiveness (Nadler, 1965).

1.2 Definition of Terms

The following definitions of terms are included here to avoid confusion and to ensure a clear understanding of the study:

1. Centralized tray assembly conveyor system - the whole complex of interacting physical and human resources, equipment, materials, capital, space, time, and manpower necessary to assemble patient trays along a mechanized conveyor belt to the desired state of output (McGary,]968).
2. Conveyor belt - the moving belt on which the trays are transported along the stations to the checker.
3. Work position - each station along the conveyor belt for which there is a given task and one operator.
4. Operator - the individual assigned to each work station on the conveyor belt who performs the assigned duties of that station in the tray assembly system.
5. Checker - the last operator on the assembly line, and the one responsible for checking all items on the tray in harmony with the items selected on the individual menu for the patient tray.
6. Runner - an employee not assigned to any work station on the conveyor belt, but who supplies any missing items as needed at any work station.
7. Direct labor time - the time spent in any essential activity contributing directly to the production of the end product, the meal.
8. Forced delay - the time an employee is not productive due to an interruption beyond his control in the performance of a direct or an indirect work function.
9. Idle time - the time an employee is not productive due to personal or avoidable delays.

10. Phase A - the first phase of data collection. Observation of work function activities of trayline assembly personnel for one week.
11. Phase B - the second phase of data collection. Observation of work function activities of trayline assembly personnel after changes in the system had been implemented.
12. Nonproductive - the time an employee is not contributing toward planned goals.
13. Productive - effective in achieving organization goals; having the quality or power of producing desirable results.
14. Productivity index - the output of the system in relation to the time and labor input. For dietary departments it is calculated as the minutes per meal.
15. Work sampling - the estimation of the proportion of time devoted to a given type of activity over a certain period of time by means of intermittent, randomly spaced, instataneous observations (Krick, 1965).
16. Model - the representation of a real thing. Models can provide information, be used for designing, assist in evaluation, represent an operating procedure and be a means of testing a system (Nadler, 1963).
17. Queue - a waiting line, as trays diverted from the assembly awaiting corrections or additions.

1.3 Purpose of the Study

Effective utilization of manpower is predicated on the amount of labor force required and the skill mix essential for achieving organi-

zational goals. Labor productivity is always calculated with reference to some unit of time (minute, hour, day, month, or year) and comprises the whole result of labor within a unit of time determined jointly by factors dependent on and independent of the worker (Ming, 1964).

In view of the need to increase productivity in hospital food systems and considering that the patient trayline assembly is a major part of the service subsystem, the purpose of this study was to:

1. Determine the amount of both productive and nonproductive labor time for each trayline position.
2. Compare in terms of labor time and costs, two patterns of patient trayline workload distribution.
3. Test the null hypothesis that no significant differences exist between the productivity index of the trayline system studied during Phase A and Phase B.

CHAPTER II

REVIEW OF LITERATURE

A successful management system is one in which there is integration of the human, machine, material, and procedural resources of the enterprise through a planned, documented, and communicated framework to permit economy and harmony of action in meeting objectives (Feigenbaum, 1968). In short, the systems approach makes it possible for us to trace out and evaluate the efficiency and effectiveness of the energy flows, interchanges, and transformations that take place within a highly complex organization (Gilman, 1969).

The systems concept as a method of problem solving takes into account every factor that relates in any critical way to the cause of a problem or its profitable solution (Harvey, 1964).

2.1 Labor Costs for Health Care Service

Health care costs in 1970 have accentuated the need for research on labor utilization. The average cost of a hospital bed in this country is about $75 a day. Costs in some urban hospitals average $100-$118 a day while intensive care beds may average $300-$500 a day. It has been predicted that hospital costs may rise to at least $1000 a day, probably by 1980 (Powers, 1970).

Most health system analysts have reached the conclusion that the health delivery system must (1) utilize the findings of research to

reorganize for increased efficiency and (2) innovate new techniques for changes and improvements in health care.

Labor costs account for two-thirds of total hospital costs. Productivity has not kept pace with the rising wages in hospitals; rather, the number of employees per patient has increased (McGary and Donaldson, 1969). Bennett (1968) believes that the absence of integrated long-range training programs with a continuing investment of time and money is the greatest disadvantage to the hospital manpower problem.

During the ten-year period from 1952 to 1962, total expenses per patient-day rose 101 per cent and the number of employees per patient, 35 per cent (Rothenbuhler and Bartscht, 1965). Hospital costs have increased 59 per cent since 1966 (Hitt, 1970). Morris (1970) feels that hospitals' inability to move at a pace commensurate with the business world shows an appalling lack of flexibility in meeting day-to-day problems and that the idea of reducing hospital costs today is wishful thinking. He feels that costs can be contained through innovative procedures. Peters (1968) predicts that the increase in hospital costs will be even greater in the next few years than in the last few. He suggests that it may well be 15 to 20 per cent instead of the usual 5 to 7 per cent, and asserts that it will be primarily as a result of rapidly rising personnel costs. Christopher (1968) feels that since payroll is now reaching as much as 80 per cent of operating costs, any attempt to curtail mounting hospital price structures must place its emphasis first and uppermost on payroll and the personnel that payroll represents. Hospitals must pay much more attention to doing things differently in the interest of doing them better, more economically,

with less effort. If hospitals are able to save personnel time, thereby increasing employee productivity, there is no greater contribution that those institutions could make to society (Harvey, 1969).

Labor Costs of Food Service System. The critical problem of food service in a health care system is the cost of labor. Faced with continuing rising costs of essential resources, administrators must find ways to improve the level of productivity without increased amounts of expensive and scarce resources. Published data on labor costs for a dietary department of a hospital is scarce. Regional differences in prevailing wage rates makes comparison difficult.

Hospital Administrative Services (1969) of the American Hospital Association regularly reports special departmental and operational indicators to serve as guidelines in comparing costs. For the 3 month period ending January, 1969, the per cent of total hospital operating expense by department for hospitals of 400 beds and over was as follows:

Nursing	26.1
Administration	9.8
Dietary	8.6
Laboratory	7.1
Radiology	5.0
Plant Engineering	4.9
Operating and Recovery Room	4.8
Employee Health and Welfare	4.2
Pharmacy	3.7
Housekeeping	3.6
Medical Staff	2.7
Central Service and Supply	2.2
Laundry	1.8
Delivery and Labor Rooms	1.3
Medical Records and Library	1.2

The remainder of total operating expenses was represented by several minor departments and general overhead expense.

Specific cost indicators for the dietary department in hospitals

with 400 beds or over showed that labor costs represented 50 per cent of total department operating expense. Since the food service administrator can exert greater control over labor costs than over food and supplies cost, it is imperative that productivity be elevated to the optimal level.

2.2 Trayline System

The patient trayline assembly is a critical part of the service subsystem within the dietary department. The method of tray assembly and delivery may be centralized, decentralized or some modification or combination of these. The method used affects the staffing of the dietary department (Rothenbuhler and Bartscht, 1965). The complete assembly of the trays in the production area and delivery to patients' rooms is called centralized service. The partial preparation of food in the production area with the remaining preparation and the assembly of the trays in each ward pantry is decentralized service.

Since the hospital dietary department observed in this research used the centralized tray assembly method, it is the method to be discussed in this study.

There is a strong trend toward centralized food service systems. In a survey by Foster (1965), 26 per cent of the hospitals were using decentralized systems in 1962 and of these, 9 out of 10 expressed interest in converting to a centralized system. In 1963 only 19 per cent of the hospitals were using decentralized service and in the 1965 survey, the number using the decentralized system had dropped to 13.4 per cent. A more recent survey found that only 9 per cent of 766 hospitals were using decentralized method of tray service (Anonymous, 1968).

The ideal time for tray assembly per meal is 60 minutes with 80 minutes being the maximum (McGary and Donaldson, 1969). Reports from hospitals show an output of from 240 to 300 trays per hour of tray assembly time per meal with only one hospital reporting 400 trays per hour. There is a need in many hospitals for an improved productivity rate in patient tray assembly.

One hospital (Anonymous, 1964) reports assembling 240 trays per hour which is 4 per minute using a divided hot-cold tray and having all cold foods on one side of the conveyor and all hot foods on the opposite side, corresponding with the tray design. According to Terrell (1962), four trays per minute is standard. Four to six trays per minute or an average of 300 per hour is recommended by Tate (1966) as a goal of an efficient operation. The number of stations, type of menu, positioning of the menu items on the line, the number of employees used and the length of the trayline will influence the rate of output. Kaszmarek (1960) indicates that one hospital food service system was able, with all mobile equipment, to complete 200 trays in 30 minutes using ten employees and one dietitian. No information was given regarding the type of menu. Gunn and McLean (1964) report completing all trays for a 420-bed hospital in forty-five minutes.

Williams and Donaldson (1969) developed an evaluation program for a hospital dietary department and found that there was 26.76 per cent nonproductive time in tray assembly. This was 21.13 per cent in forced delay time and 5.63 per cent idle time. McGary and Donaldson (1969) point out that the two basic problems are interruptions in the flow of materials through the assembly system and unequal division of work among

the work positions. Any time one position causes a delay or a stoppage of the conveyor belt there is forced delay for all other positions.

Thompson, Hartman and Polletier (1960) reported a 20 per cent savings in direct labor costs when using a centralized service as compared to decentralized service. However, there was considerable variance in the rate of output or trays per minute reported. Information was incomplete regarding the number of employees on the tray assembly line, the type of menu and the length and type of conveyor.

2.3 Productive Labor Time

In food systems the rate of productivity is defined as the labor time expended per meal served. The need for qualitative and quantitative standards for comparison, evaluation, and control of productivity in the dietary department is apparent (Kent and Ostenso, 1965). Reliable methods for determining the number and kinds of employees required to operate an efficient dietary department need to be developed and utilized by each specific food service. Successful use of scientific management principles demands that each task to be performed, each procedure to be followed, each principle to be applied, be carefully studied, analyzed, and evaluated (Frazier, 1962). Past experience has shown that increased productivity reduces the manpower requirement (Groner, 1964).

Studies have indicated the need for analyzing labor time as a prelude to improving work efficiency. Schell and Korstad (1964) report the results of work analysis by means of the work sampling techniques in two Veterans' Administration hospitals. Results showed similarities and differences in division of labor time by a centralized and a

decentralized food service system. The study pointed out that labor time analysis provides dietary management with a necessary tool for efficient scheduling, controlling, and forecasting of manpower requirements. Coffey, et al. (1964) reported on the analysis of direct labor time spent each day in eight essential areas of work activity within a hospital food service operation. Conclusions were that if standards for direct labor time involved in essential work activities could be established, management would have a valuable guide for evaluating the labor budget.

Jernigan (1967) affirms that there should be on-going training programs for everyone in the department. Trayline employees should receive an explanation of what is to be done at each station and how each job relates to all others; emphasis placed on the point that if one person delays the serving procedures, everyone's job will be delayed.

One of the objectives of a dietary department is the timely movement of materials into, through, and out of the department (Hubbard, 1970). If increased productivity in the food system could be realized by more efficient utilization of labor and equipment, rising costs could be minimized (Beach and Ostenso, 1969). Research from one study has revealed that the serving of food represents 19 per cent of total labor time (Beach and Ostenso, 1969). Williams and Donaldson (1969) found that nonproductive time for a hospital dietary department was 19.95 per cent, but for the tray assembly of that department it was 26.76 per cent.

One of the largest areas of the dietary department in terms of

input of human resources, is the tray assembly system. Jernigan (1968) observed that in most food service operations there are more man-minutes wasted or misused in setting up trays than in performing any other task. One hospital food service reports (Fellers and Gue, 1965) revising the system for tray assembly with a resulting decrease in time of at least 37 per cent. Because the tray assembly system is in operation for three meals each day utilizing as many as eleven people each meal, much time can be lost with just a small percentage of nonproductive time per person. Just 10 minutes per meal of time lost means 30 minutes each day or 182 hours per year. If several people misuse time to the extent, the loss in nonproductive time can be staggering (Jernigan, 1968). Industrial engineering studies indicate that employees in food service systems work at about 40 to 50 per cent efficiency, tending to adjust to the amount of work to be done by speeding up or slowing down according to demand (Blaker, 1970). Kent and Ostenso (1965) recommend increased utilization of personnel, materials, equipment, space, and more effective manipulation of capital and time which are the controls for these inter-dependent resources. This is imperative since increased production through mechanization and automation is not possible in the dietary department to the extent it is in industry.

2.4 Model of a Centralized Tray Assembly Conveyor System

Models have been used by man throughout history to convey his thoughts and meanings. A model is a representation of a real thing. The construction of models is an art which requires the balancing of opposites (Elmaghraby, 1968). The model must be simple enough to be

constructed and studied; yet complex enough to mirror, as much as possible, the complexity of the system it claims to represent. According to Odiorne (1969) the first stage in model making is to abstract from the problem those things which are significant. This is based on the assumption that some attributes of the problem must be ignored if a decision is to be made. When the problem is complex, the model provides discipline and order. It gives the manager some variables to watch, helps him to relate those variables and helps him derive conclusions from premises. This means that periodic reports will be taken from different parts of the process with a specific purpose of testing the model with real data. The discipline of the model provides one of the best guides to developing feedback to control the decision which has been put into operation.

Functioning as effective analogues of real life, models can provide information, be utilized for designing purposes, assist in evaluation, represent an operating procedure, and can be a means of testing a system (Nadler, 1963).

McGary and Donaldson (1969) developed a model of a hospital centralized patient tray assembly conveyor system which (1) identified the components of the system, (2) provided techniques to reduce interruptions to the system and improve the balance of work distribution among operators, thus reducing idle time, (3) permitted evaluation of the efficiency of existing systems, and (4) provided a tool for redesign of existing systems and the design of new systems. In the development of the model four factors were given as pertinent to the system layout; system mechanization, assembly system dimensions, equipment mobility,

and method of control for missed or incorrect items. The essential components of the system are layout and equipment, work station content, the menu, standards, and position structure.

The quantitative standard enunciated was trays per minute; the qualitative standards were correct food items on tray, correct food and accessory arrangement, correct portion size of food items, and appropriate condition of food items (McGary and Donaldson, 1969).

CHAPTER III

METHOD

Work sampling was the industrial engineering technique used to determine the input data for this research. Statistical analysis was made of differences in labor minutes utilized between patterns of workload distribution and within positions. Labor time and cost was analyzed in relation to position on the tray assembly line.

3.1 Research Design

Environment

The research was conducted in the food service department of a 408 bed voluntary hospital with the following characteristics:

1. Production: Approximately 1012 patient meals per day, seven days a week.
2. Food service system: Centralized service with patient trays assembled in the production area and delivered to patient areas.
3. Personnel: 4 administrative dietitians (including the Director of the dietary department), 6 therapeutic dietitians, and 58 full-time supportive personnel (40 hour week) and 55 part-time.

Work Sampling Methodology

Work sampling is a fact-finding tool which, in many cases, can provide information about men and machines in less time and at lower cost than by other means. The technique is based on the law of probability which states that the characteristics of random samples of a group tend to resemble the characteristics of the whole group if the sample is large enough (Barnes, 1963). Work sampling is an efficient and economical tool for improvement of work efficiency and control of quality. The necessary steps in planning and conducting a work sampling study are: (1) examine and define the objectives, (2) determine the time period for the study, (3) classify activities into categories, (4) make a preliminary estimate of the percentage of time required by various work activities, (5) determine the number of observations required for reliability, (6) establish observation intervals and random times of observation, (7) design the forms needed for recording data, (8) orient personnel, (9) conduct the study, and (10) evaluate the results (Hansen, 1960). Work sampling is a quantitative technique for measuring and analyzing the activities of employees and is particularly useful in the analysis of nonrepetitive activity where complete descriptions are not available (Heiland and Richardson, 1957).

Studies reported using work sampling indicate that it is a reliable research tool (Johnson, 1960; Mastin and Ferrell, 1964; Kent and Ostenso, 1965). Data secured through work sampling may be employed as a technique to determine the effect of a change in procedure on labor time and the productivity index.

In work sampling, the greater the number of observations, the

higher the degree of accuracy. Brisley (1952) states that work sampling has the advantage of being only one-third to one-sixth as costly as continuous observations; but providing the accuracy required. Observers do not require a long period of training. The method provides a practical method of obtaining facts which otherwise might be impossible to get, is less upsetting to routine, and causes fewer complaints from the workers than continuous observation.

To determine the amount of productive and nonproductive time (idle and forced delay time) work sampling was used in observing the tray assembly in operation. Preliminary steps were taken to obtain the cooperation of the employee and to cause a minimal change in the normal work routines.

These steps included:

1. Conferences with the Administrative Dietitian to obtain permission to conduct the study in the hospital dietary department.
2. Meetings with the employees to assure them that the study would not affect their job security and to explain what the project would involve.
3. A training period for the observers to assure their competence and accuracy in recording observations.
4. Preparation of forms for making and recording the observations.

Phase Structure

The study was divided into two phases. Phase A represented a one-week period of observation of work function activities of the operators

on the tray assembly operation. Analysis of the activities from this phase was utilized to determine the changes to be implemented before Phase B.

Changes made in trayline operations following Phase A included (1) application of work simplification techniques for position 10 to increase the motion economy of the operator, (2) removal of one section of shelving above the conveyor belt to increase visibility of the menu, and (3) the scheduling of an operator to the runner position for the breakfast meal on the same basis as for the dinner and supper meals.

Selection of Observers

Dietetic interns and one graduate student in Food Administration were chosen as observers. In addition there was one individual from the community with previous experience as an observer for work sampling studies. Training for each observer included a review of work sampling methods and actual experience in making and recording observations of the tray assembly operation. There was one observer for each two positions on the trayline, except for one position. There was one observer who was assigned to observe the "runner" only because of the nature of this position. The "runner" is continually moving from production area to serving area and from one position to another on the conveyor belt. One observer was scheduled, not to observe work functions, but to record an accurate count of the trays served in the following three menu-type categories: regular and soft, modified, liquid and nourishment. This observer also recorded the beginning and ending times of trayline operation for each meal.

Orientation of Employees

Prior to performing the study, an orientation meeting was held with the employee who were to be observed. The purpose of the study and the techniques for observing and recording activities were explained. Emphasis was given to performing the normal work activity in the normal way. It was clearly stated that the observer was interested in what work activity was being performed and not in why or how it was done. It was stressed that the individual employee was not being evaluated and that job security would not be affected. Names of employees were not used. Each worker was identified only by the work station number or position he occupied on the day of the study.

Length of Study

A seven day period was chosen as being representative of all normal activities on the tray assembly system. This included the normal variations in menu offering and was typical in distribution of both regular and relief personnel.

A seven day period, January 18 through 24, 1970, was chosen as Phase A for the work sampling study. This was the second week of the four-week cycle menu. Phase B was June 7 through 13, 1970, also the second week of the four-week cycle. This ensured that the menu offering was the same for both phases of the study.

Nineteen weeks elapsed between Phase A and Phase B. During this period the trayline operation was observed once each week on random days for the three meals. From these observations, the following data were obtained:

1. Total time of the trayline operation for each meal.
2. The rate of output from the system in trays per minute.
3. The ratio of trays in each of the three menu-type categories; regular and soft, modified, liquid and nourishment.
4. The number of trays corrected or double-checked at the end of the trayline.

Determining Frequency of Random Observations

The accuracy of the data determined by work sampling depends upon the number of observations. Unless the sample size is of sufficient quantity, inaccurate results will occur (Niebel, 1967). Equal portioning of the total observations specified for the seven day sampling period required a minimum of 143 observations a day for each position. The times of the observations were determined by drawing from a table of random numbers and transposing these to times in accordance with instructions in Methodology Manual for Work Sampling (Institution Management Personnel, 1967). Observations were made only during the time expended in assembling equipment and food for trayline service and actual tray assembly, disassembly of trayline, and clean-up. These times were as follows: 6:40 to 8:15 a.m. for the breakfast meal; 11:45 a.m. to 1:30 p.m. for the noon meal and 4:40 to 6:30 p.m. for the evening meal.

Selection of Work Function Activities

Work function activities as defined in the Methodology Manual for Work Sampling (Institution Management Personnel, 1967) were used as a

basis for the study. Actual observations indicated those work functions which were relevant to tray assembly. Additional work functions were added to define more accurately and in finer detail the activities of the tray assembly personnel in the hospital studied. The work function classification as used in this study is shown in Figure 1.

3.2 Trayline Assembly

Part I: Present Method

In the hospital studied the patient tray assembly system required 12 people for the breakfast meal and 14 people for the noon and evening meals. The positions were assigned as follows: 9 persons on the conveyor belt, one person as a checker, one person loading the carts and another person transporting the carts to the dumbwaiters. There was also one or more dietitians or supervisors who inspected and corrected trays as necessary plus one runner who supplied all missing items on the tray. One dietary employee was stationed on the patient wards to remove carts from the dumbwaiter, transport them to the patient areas and collect and return soiled trays back to the kitchen after the meal period. This employee was not included in the study since the observations were to be of the tray assembly only.

The conveyor belt was 30 feet long and the cart for setting up the trays extended another 4 feet 3 inches at one end and the table for correcting trays adds an additional 6 feet at the other end of the conveyor, making a total length of just over 40 feet. All work positions were perpendicular to the tray assembly belt.

There were 4 positions for hot food on the right side of the conveyor belt. Extra supplies for these stations were stored in holding

WORK FUNCTION ACTIVITIES

DIRECT WORK

1. Serving
   - A. Assembling trays
   - AA. Scraping deck pans
   - B. Checking trays (inspection)
   - BB. Setting down menu holder
   - C. Covering soup or cereal bowls
   - CC. Putting menu on holder
   - D. Cutting
   - E. Ladling soup or cereal
   - F. Looking in cupboard or refrigerator or drawer
   - G. Opening or uncovering containers
   - H. Picking up plate, bowl or dish or cover - picking up food
   - I. Preparing milk containers for serving line
   - J. Placing food or dish on tray or plate
   - K. Pouring drinks
   - L. Putting cover on plate
   - M. Putting napkin on tray
   - N. Putting tray into cart
   - O. Putting bread in toaster or removing toast from toaster
   - P. Reaching for dish, pot, plate or food
   - Q. Reading individual menu
   - R. Removing tray from belt or table
   - S. Setting up steam tables, cold counters, carts, trays, nourishments
   - T. Stirring
   - U. Transfer of trays of food from cart to serving line
   - V. Spooning food into dishes
   - Y. Discarding dirty or chipped dish
   - Z. Weighing

2. Transportation
   - A. Carts of food to trayline or away from line
   - B. Filled carts to dumbwaiter
   - C. Pushing empty carts to trayline for filling
   - D. Empty carts to trayline for filling
   - E. Removal of empty containers from trayline
   - F. Single trays to dumbwaiter
   - G. Transfer of supplies to or from trayline
   - H. Walking empty
   - I. Walking with message
   - J. Walking with empty container
   - K. Looking in dumbwaiter
   - L. Walking with tray or dish of food

3. Clerical
   - A. Giving message
   - B. Receiving message
   - C. Telephone calls
   - D. Writing on clipboard

INDIRECT WORK

4. A. Giving instructions
   - B. Inspection of food (trays)
   - C. Inspecting size or quality
   - D. Tasting of food
   - E. Standing - evaluating trayline
   - F. Moving tray on table

DELAYS

5. Forced delays
   - A. Assembly belt stops
   - B. Wait for corrected trays
   - C. Wait for dishes or supplies
   - D. Wait for dumbwaiter
   - E. Wait for food
   - F. Wait for trays - slow belt
   - G. Wait for line to start
   - H. Looking for food
   - I. Looking at equipment and adjusting
   - J. Handing dish or utensil to another
   - K. Holding trays back on conveyor belt

6. Personal delays
   - A. Adjusting hairnet or dress
   - B. Putting on or taking off apron, cap, or gloves
   - C. Drinking fountain
   - D. Washing hands

7. Idle time
   - A. Conversation not pertaining to business
   - B. Telephone (personal)
   - C. Loafing

8. Cleaning
   - A. Cleaning work area
   - B. Wetting or rinsing cloth
   - C. Washing utensils
   - D. Cleaning up spill on tray

Figure 1. Work function classification for patient trayline.

ovens adjacent to the positions. There were 4 positions for cold foods and beverages on the left side of the conveyor belt. These positions were supplied from refrigerators and from extra carts located immediately behind the cold food positions.

The conveyor belt was a permanent installation. All other equipment and tables in the assembly system were mobile.

The menu for the hospital studied was a rotation four-week cycle menu with limited selectivity on all diets. The menu selection included a minimum of two soups, two entrees, two vegetables, and two or more salads and desserts for both the regular and modified diets. Tate (1966) observed that the number of menu items offered each meal has a direct bearing on the rate of trays per minute from the system.

The tray assembly position or "starter" placed the tray cover, silver, individual salt or salt substitute, sugar or sugar substitute. The starter also placed the menu on an upright holder and put this on the conveyor belt immediately preceeding the tray to which it belonged.

Each position included both the regular house diet and modified diet foods in that category; that is, the dessert position would also include the desserts and fruits for the modified diets, the vegetable position would include all the vegetables for modified diets, etc. The operator at position number 55 placed the napkin on top of the plate cover and transferred the finished tray from the conveyor belt to the cart which was sent to the patient floor.

Part II: Model Method

The model suggested by McGary and Donaldson (1969) included 9 positions plus the floater (runner), as in the hospital studied. A

queue for diverting trays at the end of the trayline requiring additions or corrections is part of the system. In McGary and Donaldson's model the queue length was adequate for only 3 trays at one time since more than this should not be necessary if the system is operating efficiently. In the hospital studied in this research, space was provided and often used for 6 or more incorrect trays at one time.

The two positions for cold foods were located on opposite sides of the conveyor belt and preceded the 5 hot food positions. In the hospital system studied, all hot positions were on the right side of the conveyor belt: all cold positions on the left side.

The model in McGary and Donaldson's study and the tray assembly system of the sample hospital studied had a permanently installed straight line assembly conveyor belt. Mobile equipment (food, dish and silverware holders) was used which is essential as it provides flexibility in arrangement from meal to meal. Serving units were perpendicular to the conveyor belt for more efficient movement of the operators. This also provided ease in reading the individual menus. In McGary and Donaldson's model the menu stood at the forward edge of each tray whereas in the hospital system studied the menu was mounted on a metal stand and preceded the tray. Both systems used color coded menus for quick identification.

Activation of Solution Suggested by the Model. Phase A of the work sampling study was designed to determine the amount of both productive and nonproductive time for each position for each meal. Observation of the on-going activities, conversation with management and supervisory personnel, and tabulation of the collected information

from Phase A of the work sampling study, focused attention on the following situations:

1. Position work content was not evenly distributed for all positions. This caused much forced delay time at some positions, while at others, the operators had almost no delay time.
2. There was a high frequency of missed or incorrect items on the trays.
3. It was necessary for operators to hold trays back from forward progress on moving conveyor belt.
4. Some operators had difficulty in reading the menu.
5. Forced delay at times was caused by factors outside the system.

Recommendations from Phase A. In consultation with the administrative personnel, it was indicated that it was feasible, at this point in time, to implement three recommendations, namely:

1. The operator in Position 1, starter, should be taught to use motion economy. In the present method, much wasted motion was apparent.
2. The second section of shelving over the conveyor belt should be removed to provide better visibility of the menu. The supports of this shelf also obstructed the movements of several operators on the line.
3. The "runner" position should be scheduled for each meal and that this individual was to be educated to watch and to

listen for needed items. This would include supplies as well as food items.

3.3 Data Collection

Since the purpose of this research was to obtain labor time estimates, which could result in small values of time, to be used as a comparative basis for determining significant differences between two patterns of workload distribution, a small sampling error was desired. Therefore, a confidence interval of $\pm$ .05 was deemed realistic and desirable.

To obtain a maximum sampling error in terms of a confidence interval of $\pm$ .05 and a confidence coefficient of .95, a sample size of 990 observations per position was required for each phase of the study. Equal distribution of the total observations required over the one week study for each phase resulted in 143 observations per day of each position.

Observation forms designed to facilitate data collection included the following and are shown in Appendix B:

1. Randomly selected observation position-time periods (Form 1)
2. Matrix: work areas and quarter-hour time intervals (Form 2)
3. Observation times arranged in sequential order - A.M. (Form 3)
4. Observation times arranged in sequential order - P.M. (Form 4)
5. Daily observation sheets (Form 5)
6. Tally sheet for work sampling observations (Form 6)
7. Daily tray count by meal (Form 7)

3.4 Data Input

A computer program for processing the data was written in Fortran for the IBM 1620 computer. Input data were punched on IBM cards. Three sets of input cards were punched and verified. These were as follows:

Set I. Position code, employee code, day and meal codes and work function codes for each meal.

Set II. Position code, employee code, day and meal codes and total minutes expended in that position by that operator.

Set III. Employee code with hourly pay rate.

Labor Time: Statistical treatment

Mean per cent of labor time utilized in work function activities for all patient trayline positions was analyzed statistically to determine differences for positions and differences for days between Phase A and Phase B.

Labor Time: Monetary evaluation

The estimated distribution of labor minutes over the various positions was obtained for each meal and each day. Labor cost per meal and per day in each position was calculated.

Statistical tests were made to determine the differences in labor cost between Phase A and Phase B by positions and by meals.

A statistical test was made to test the null hypothesis of no significant difference between trays assembled per minute by two patterns of workload distribution within food assembly positions. Labor

time utilized was evaluated in relation to total monetary value expended in the two patterns.

CHAPTER IV

FINDINGS AND DISCUSSION

Work sampling was the method used to collect data concerning work function activities of personnel on patient trayline assembly for one-week periods during Phase A and Phase B. The sample hospital was a general, short-term, non-federal facility.

The food service system in the sample hospital was designed for centralized tray assembly utilizing one continuous conveyor belt with operators stationed at positions on both sides of the belt. For clarity in observing and recording work function activity, each position was identified by the number of the position on the employee schedule. These numbers were not always the same for the three meals. For example, the position at which the operator placed the napkin and loaded the trays into carts was called position 8 for breakfast, while, for the dinner and supper meals, it was called position 10. This procedure was followed because fewer positions were required for tray assembly at breakfast since there was less variety in the menu selection.

It was essential to have one number to identify the same position for all three meals of the day when preparing the input data for the computer. Thus, positions 8 and 10 as given above became position 55

for all three meals. The code numbers used for each of the positions were as follows: (Figures 2 and 3)

Code Number	Position Number	Description of Position
10	1	Starter (tray assembly operator)
15	2	Cereal and soup operator
20	3	Egg, hot bread and entree operator
25	4	Hot beverage, potato and roll operator
30	5	Vegetable operator Dinner and Supper meals only
35	5, 6	Fruit, juice and salad operator
40	7	Dessert and fruit operator Dinner and Supper meals only
45	6, 8	Beverage packets and cream operator
50	7, 9	Toast, hot water and parsley operator
55	8, 10	Napkin, cart loading operator
60	9, 11	Operator moves carts to dumbwaiters
65	11, 13	First checker
70	12, 14	Second checker
75	13, 15	Runner (float) brings foods and supplies to assembly line
80	14, 16	Dietitian or Supervisor (support to second checker)

4.1 Productive and Nonproductive Time

One of the objectives of this study was to compare the proportions of productive and nonproductive time in the trayline assembly operations during Phase A and Phase B. Productive was designated as that time spent in (1) service functions, (2) transportation, (3) clerical, (4) indirect work as in training personnel and giving instructions, and (5) clean-up. Nonproductive was time the operator was observed in (1) forced delay, (2) personal delay, or (3) idle time.

Input data for the computer program included the day, meal, and the number of observations in each work function for each position. The program for the computer was written to print the frequency of observations for each position for each meal during Phase A and Phase B.

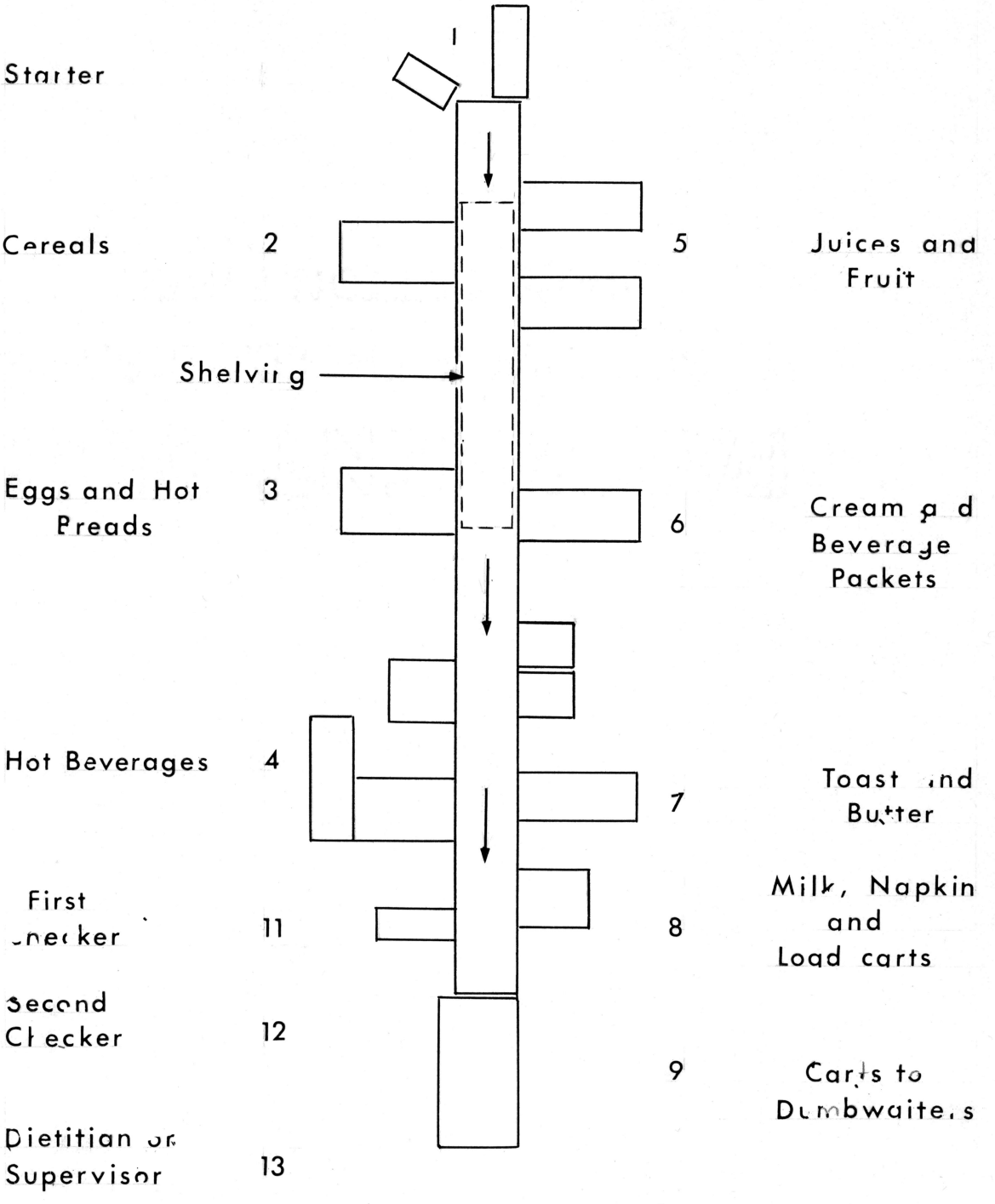

FIGURE 2. OPERATOR POSITIONS ON PATIENT TRAY ASSEMBLY FOR THE BREAKFAST MEAL.

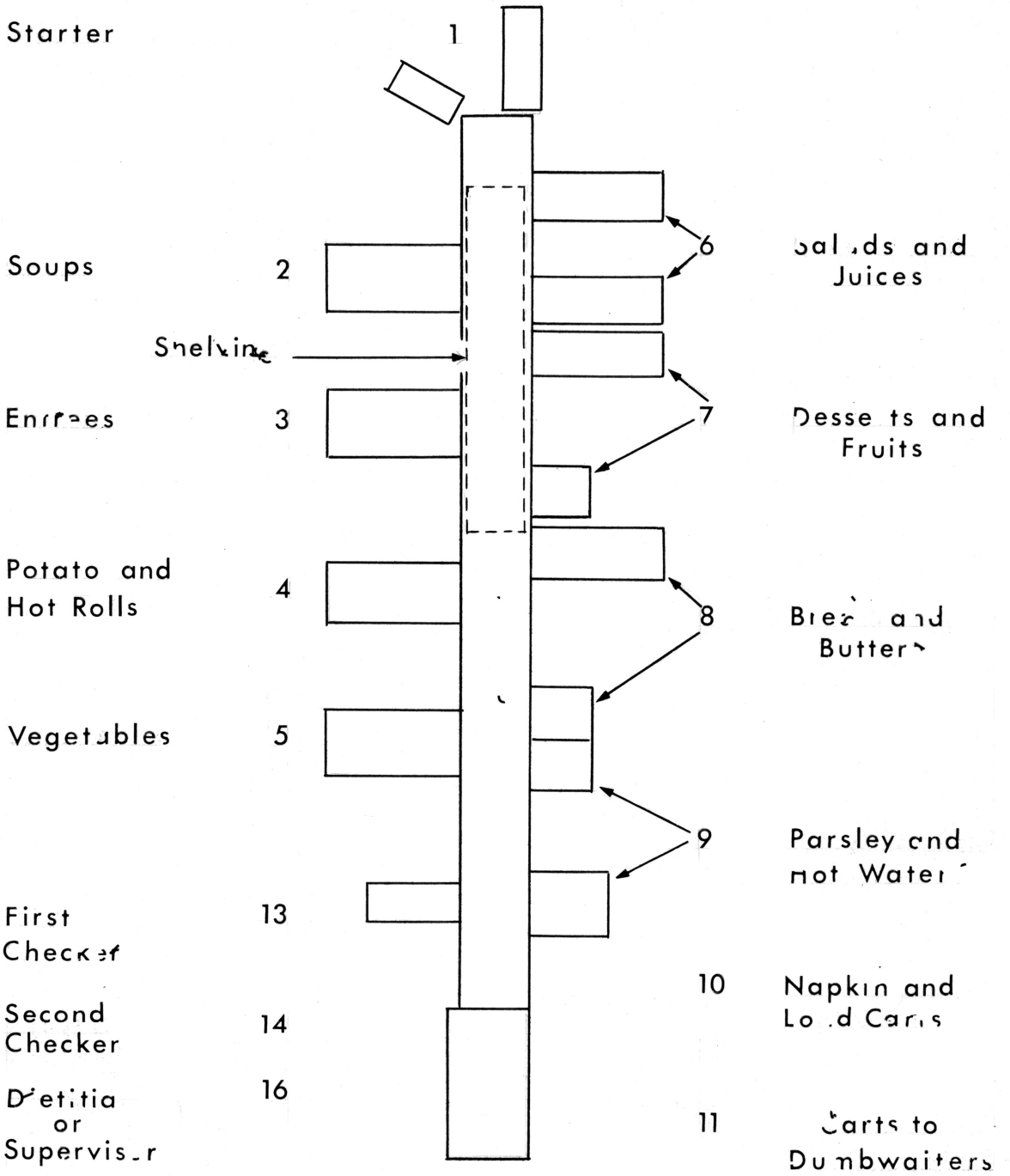

FIGURE 3. OPERATOR POSITIONS ON PATIENT TRAY LINE ASSEMBLY FOR THE DINNER AND SUPPER MEALS.

Subtotals for each category were computed and included in the printout. Proportions of productive and nonproductive time were calculated from the data generated for the computer printout.

Data indicated that the mean proportion of productive time by position for the breakfast meal ranged from 70.93 per cent for position 45 to 98.81 per cent for position 75 during Phase A (Table 1). During Phase B the range was from 76.35 per cent for position 35 to 99.59 per cent for position 75. For the dinner meal the mean proportion of productive labor time ranged from 71.51 per cent for position 45 to 95.98 per cent for position 10 during Phase A. The range during Phase B was from 70.80 per cent for position 30 to 98.90 per cent for position 75 (Table 2). Table 3 shows the mean proportion of productive labor time for the supper meal ranged from 63.49 per cent for position 45 to 93.53 per cent for position 10 during Phase A and a range of 69.77 per cent for position 40 to 96.28 per cent for position 75 during Phase B.

Statistical tests were done on 281 meals, by position, to determine whether or not there was any significant difference in the nonproductive labor time for each meal by position during Phase A and Phase B. There were 8 meals for various positions for which there was significantly less nonproductive time during Phase A than during Phase B (Table 4). However, the results showed 30 meals in various positions for which there was significantly less nonproductive time during Phase B than during Phase A (Table 5). Significance test was the Z value tested at the 0.05 level.

During both Phase A and Phase B there were some meals in which more than one operator was in a specific position. This condition was

TABLE 1. MEAN PROPORTION OF PRODUCTIVE AND NONPRODUCTIVE LABOR TIME BY POSITION ON PATIENT TRAYLINE ASSEMBLY OF THE BREAKFAST MEAL FOR ONE WEEK PERIODS DURING PHASE A AND PHASE B.

	PRODUCTIVE		NONPRODUCTIVE	
Position	Phase A	Phase B	Phase A	Phase B
	(%)	(%)	(%)	(%)
10	97.90	95.91	2.10	4.09
15	94.47	92.66	5.53	7.34
20	84.60	91.00	15.40	9.00
25	78.96	85.81	21.04	14.19
30++				
35	76.75	76.35	23.25	23.65
40++				
45	70.93+	86.23+	29.07+	13.77+
50	80.80	84.75	19.20	15.25
55	76.39	83.12	23.61	16.88
60	84.66	84.30	15.34	15.70
65	85.84	96.70	14.16	3.30
70	81.98	95.37	18.02	4.63
75	98.81	99.59	1.19	0.41
80	82.30	78.24+	17.70	21.76+

+ Indicates positions in which additional personnel were involved in on-the-job training.

++Not utilized on breakfast trayline.

TABLE 2 MEAN PROPORTION OF PRODUCTIVE AND NONPRODUCTIVE LABOR TIME BY POSITION ON PATIENT TRAYLINE ASSEMBLY OF THE DINNER MEAL FOR ONE WEEK PERIODS DURING PHASE A AND PHASE B.

	PRODUCTIVE		NONPRODUCTIVE	
Position	Phase A	Phase B	Phase A	Phase B
	(%)	(%)	(%)	(%)
10	95.98	92.72	4.02	7.28
15	83.22	89.14	16.78	10.86
20	82.14	83.16	17.86	16.84
25	78.84	77.15	21.16	22.85
30	74.17+	70.80+	25.83+	29.20+
35	65.66	64.15	34.34	35.85
40	68.40	66.90	31.60	33.10
45	71.51	77.42	28.49	22.58
50	84.46+	78.84	15.54+	21.16
55	69.59	78.60	30.41	21.40
60	79.56	83.33	20.44	16.67
65	84.88	97.27	15.12	2.73
70	91.04	88.70+	8.96	11.30+
75	92.13	98.90	7.87	1.10
80	86.70	88.33+	13.30	11.67+

+Indicates positions in which additional personnel were involved in on-the-job training.

TABLE 3. MEAN PROPORTION OF PRODUCTIVE AND NONPRODUCTIVE LABOR TIME BY POSITION ON PATIENT TRAY ASSEMBLY OF THE SUPPER MEAL FOR ONE WEEK PERIODS DURING PHASE A AND PHASE B.

	PRODUCTIVE		NONPRODUCTIVE	
Position	Phase A	Phase B	Phase A	Phase B
	(%)	(%)	(%)	(%)
10	93.53	91.05	6.47	8.95
15	76.00	78.85	24.00	21.15
20	75.58	71.10	24.42	28.90
25	75.86	89.90+	24.14	10.10+
30	69.05	84.75	30.95	15.25
35	63.63	74.40	36.37	25.60
40	64.33	69.77	35.67	30.23
45	63.49	76.00	36.51	24.00
50	76.34	78.70	23.66	21.30
55	67.70	70.72	32.30	29.28
60	93.52	95.47	6.48	4.53
65	90.73	94.07	9.27	5.93
70	91.50	80.64	8.50	19.36
75	83.48	96.28	16.52	3.72
80	79.52	85.23+	20.48	14.77+

+Indicates positions in which additional personnel were involved in on-the-job training.

TABLE 4. MEALS BY POSITION FOR WHICH THE PER CENT OF NONPRODUCTIVE LABOR TIME WAS SIGNIFICANTLY LESS FOR PHASE A THAN FOR PHASE B.

Position	Day	Meal	Phase A	Phase B	Z Value
			(%)	(%)	
15	7	Dinner	6.98	26.32	2.366
25	4	Dinner	12.20	30.00	2.04
35	1	Dinner	18.37	45.24	2.769
50	6	Dinner	8.70	25.00	2.074
55	1	Breakfast	2.38	15.79	2.120
70	2	Supper	2.00	17.39	2.580
70	4	Supper	2.33	38.10	4.126
70	5	Supper	2.27	13.89	1.963

TABLE 5. MEALS BY POSITION FOR WHICH THE PER CENT OF NONPRODUCTIVE LABOR TIME WAS SIGNIFICANTLY LESS FOR PHASE B THAN FOR PHASE A.

Position	Day	Meal	Phase A	Phase B	Z Value
			(%)	(%)	
15	4	Dinner	24.00	5.88	-2.560
15	3	Supper	27.66	10.26	-2.017
20	7	Breakfast	13.95	0.00	-2.420
25	1	Breakfast	36.59	12.20	-2.571
25	3	Dinner	46.81	20.45	-2.650
25	5	Supper	25.58	5.26	-2.487
30	4	Dinner	39.58	11.36	-3.080
30	7	Supper	36.59	13.89	-2.266
35	7	Dinner	55.56	29.73	-2.345
35	4	Supper	51.11	24.39	-2.550
35	5	Supper	52.00	24.32	-2.603
45	5	Breakfast	18.42	2.50	-2.316
45	1	Dinner	35.29	9.30	-2.965
45	6	Supper	40.54	13.64	-2.752
50	6	Breakfast	36.17	7.69	-3.112
50	1	Dinner	38.00	17.39	-2.244
50	1	Supper	17.39	2.78	-2.100
55	3	Breakfast	39.22	6.52	-3.780
55	7	Supper	47.50	22.86	-2.218
60	6	Supper	17.50	2.33	-2.340
65	3	Breakfast	14.00	2.17	-2.095
65	2	Dinner	20.83	0.00	-3.340
65	6	Dinner	17.07	2.56	-2.163
65	7	Dinner	18.60	2.56	-2.321
75	2	Dinner	8.57	0.00	-1.980
75	3	Dinner	27.27	7.69	-2.356
75	6	Dinner	9.52	0.00	-1.98
75	3	Supper	23.08	3.70	-2.083
75	6	Supper	16.00	0.00	-2.879
75	7	Supper	38.23	0.00	-3.680

Z Value shows significance at .05 level.

due to on-the-job training of new personnel. Statistical comparison could not be made of the mean productive and nonproductive times between the two weeks since the number of personnel on the trayline did not remain constant.

Labor Time by Positions

Position 10. This was the Starter position at which the tray was assembled with paper tray cover, silverware, individual sugar and salt packets, or sugar and salt substitute packets. It was necessary for the operator in this position to place the menu on the menu holder read the menu heading and note the color coding to determine the type of diet prescribed. The menu holder was placed on the conveyor belt and the tray was assembled and placed on the conveyor belt in a position immediately following the menu. The requirements for the operator in this position were constant alertness, accuracy, fast and efficient movements.

Tabulation of the work function activities for each position following Phase A indicated that there was minimal nonproductive time in position 10 but much more in the positions where the food was placed on the trays along the conveyor belt. The greatest per cent of this nonproductive time was in forced delay. Additional study would be required to determine if these positions along the conveyor belt were lower in work content than the Starter position.

During Phase A the menus and menu holders were placed on a small cart to the right of the operator in position 10. The menus were placed on menu holders by the runner or by some other person in the department. The operator in position 10 first turned 45 degrees to the right and

then back to the original position as each menu was picked up. It was also necessary to read the menu heading to determine what was needed on that tray.

One of the principles of motion economy as given by Blaker (1965) states that equipment, materials, and tools should be arranged so as to require the least possible movement on the part of the operator. Application of this principle was made in Phase B for the regular operator for position 10. The change involved placing the menu holders on the cart at the operator's right while the menus were placed on the left. The operator was then able to use greater motion economy. The motions of the arms were made in opposite and symmetrical directions and were made simultaneously as both the menu and menu holder were picked up. The operator was able to perform this function without turning the body. The menu could be read sufficiently as it was being put on the holder. This eliminated the need for additional personnel. The operator at this position was most cooperative and seemed to enjoy using the revised method.

The revised method of picking up and placing the menus and menu holders did not appear to change the speed with which the operator in this position was able to function. Nonproductive time remained low for position 10 during Phase B but was not significantly less than during Phase A and, in some cases, was higher than in Phase A. This may have been due to (1) inability of the operator to move more quickly, (2) uneven work distribution among positions, (3) frequent stopping of the conveyor belt due to incorrect or missing items or (4) new personnel functioning in this position for some meals during Phase B.

Position 15. The operator at this position served both the dry and the cooked cereals for the breakfast meal and the soups and broths for the dinner and supper meals. No attempt was made to change this position workload nor to alter the method of movements by the operator. Findings did not indicate any significant difference in productive and nonproductive times between Phase A and Phase B.

There was more nonproductive time for the supper meal than for the breakfast and dinner meals. This was thought to be due to the fact that the operator in this position at supper meal did not check the condition of the bowls used. The regular operator for the breakfast and dinner meals carefully inspected every bowl to be used and discarded many of them because they had been sent from the dishroom with dried food particles.

Positions 20 to 45. These were the positions on the two sides of the conveyor belt where both the hot and cold menu items were placed on the trays. It was in these positions that a large amount of the nonproductive time was found. Various suggestions as to distribution of workload were discussed but it was not felt possible, by the administrator, to make any changes in the work content of these positions at that time.

Position 50. The operator at this position made the toast and placed toast and/or butter, crackers and sometimes parsley on the trays. It was necessary for the operator to utilize extra space for supplies during the tray assembly operation. The forward section of shelving above the conveyor belt provided the space needed at this position.

Following the observation period during Phase A, it was recommended

that the forward section of shelving above the conveyor belt be removed as it hampered visibility for several positions. It was observed that the operator in this position, as well as positions 25 and 30, was continually bending the head forward and down to read the menu. The supports for this shelving were mounted on the conveyor belt framwork and these supports caused some restrictions in the placement of the mobile equipment for the positions as they had to be placed so that the operator would not be reaching around the support each time an item was placed on a tray.

It was felt that the removal of this shelving would (a) increase visibility of the individual menus, (b) reduce fatigue since the operators were bending over to read each menu, and (c) increase freedom of movement for the operators.

When the shelving was removed it was necessary to add one small stainless steel shelf to a mobile table in order to provide the necessary space to place butter, margarine and bread during the serving operation for position 50. This change was made three weeks prior to Phase B. The reaction of one operator for position 50 was negative at first but this attitude changed after two days and there was complete cooperation.

Positions 55 and 60. The operator in position 55 placed the napkin and loaded trays from the conveyor belt or correction table into the carts. For the breakfast meal the milk cartons were placed on the tray at this position. Operator in position 60 transported loaded carts to dumbwaiters, received and sent messages to the patient floors regarding the carts and individual trays, and received empty carts and incorrect

trays from the floors. The operators in these positions worked closely together because of their mutual responsibility in getting the correct trays and/or carts to the patient areas.

No change was attempted for these positions. Changes in productive and nonproductive time was felt to be due to differences in personnel assigned to these positions.

Position 65. This is the first checker. The operator at this position was responsible for having all operators for the trayline assembly present and at their positions with all necessary foods and supplies prior to starting the assembly operation for the meal. This operator then checked all trays against the individual menu for that tray and indicated to the operator in position 55, by the position in which the menu was placed, whether the tray was ready to be loaded or was to be diverted to the correction table. Certain calorie and/or sodium restricted diet trays were identified by a red tag. Those trays with a red tag were also diverted and had to be checked a second time.

The operator for position 65 was somewhat hampered both in her movements and in visibility of other operators by the forward section of shelving which was mounted over the conveyor belt. Following Phase A this section of shelving was removed. The increased visibility and the freedom of movement that resulted seemed to be appreciated by the personnel in this position. This step was in harmony with the principle stated by Blaker (1965) that provision should be made for good visibility both for working and for inspecting. There were several comments from personnel expressing appreciation for the removal of this section of shelving.

Position 75. The function of the operator in this position was to run errands for any positions as necessary during the tray assembly operation. The operator must be alert and ready to bring to the conveyor belt any food or supply items needed during the meal. This person was observed in work function IW more than any of the other positions because of the nature of that position. For the breakfast meals, IW or "out of area" was observed an estimated 89.64 per cent of the time during Phase A and 78.78 per cent of the time during Phase B.

Since the work function IW or "out of area" is listed as productive labor time (Figure 1), the productive labor time for this position was very high. This was particularly true for the breakfast meals because, during Phase A, the operator worked in another area of the kitchen during the breakfast meals. The operator served in position 75 for breakfast only as called, but was available at the trayline for the dinner and supper meals.

Following Phase A, it was recommended that the operator in position 75 be present at the trayline conveyor belt for the breakfast meals as well as for dinner and supper. This was an attempt to (a) facilitate replenishment of foods and supplies more quickly, (b) reduce the number of times the conveyor belt was stopped, and (c) decreased the frequency of missed items on the trays. This change was made. However, the runner was observed as out of the area 100 per cent of the time during the breakfast meal on four days during Phase B (Table 6). Personnel for this position on these days seemed either unable or unwilling to alter the previous schedule as requested.

Positions 70 and 80. These positions are defined as, "Second

Checker" and "Dietitian or Supervisor." These were the positions in which the operator double checked certain designated modified diet trays and corrected other trays as they were diverted to the correction table. Personnel in this position were usually supervisory personnel, dietetic interns, or dietitians. There was no observable distinction between the duties for positions 70 and 80.

It was in these positions that the observation of more than one operator for a given position and meal was most frequent. Some degree of duplication of personnel was unavoidable due to the on-going program of training dietetic interns. However, extra dietary staff personnel were observed for these positions more often during Phase B than during Phase A.

Since the duties of personnel for these positions included supervision of tray assembly, correcting errors, giving instructions, and training new personnel, a substantial amount of the productive labor time was indirect work. Table 7 shows the proportion of indirect work observed in positions 70 and 80 during both Phase A and Phase B.

Number of Corrected Trays per Meal

During Phase A it became apparent that the trays requiring correction often exceeded the space provided for 6 trays. It was decided that during Phase B an accurate count of the number of corrected trays would be recorded.

One observer was assigned the task of recording the starting and stopping times of the tray assembly operation for each meal. This person also recorded the number of general and soft, modified diet, and liquid or nourishment trays assembled each meal. During Phase B this

TABLE 6. MEAN PROPORTION OF THE TIME OPERATOR FOR POSITION 75 WAS OBSERVED AS "OUT OF AREA" (IW), AND THE Z VALUES FOR BREAKFAST, DINNER AND SUPPER MEALS DURING PHASE A AND PHASE B.

	PHASE A	PHASE B	
Day	IW	IW	Z Value
	(%)	(%)	
		BREAKFAST	
1	63.99	43.24	-1.777
2	93.94	100.	0.423
3	94.29	62.50	-3.197*
4	94.44	45.71	-2.791*
5	94.29	100.	0.389
6	88.10	100.	0.428
7	100.	100.	0.000
Mean	89.64	78.78	-1.257
		DINNER	
1	69.05	40.54	-2.546*
2	22.86	38.64	1.498
3	25.00	23.08	-0.204
4	20.00	39.02	1.874
5	25.00	34.15	0.875
6	14.29	41.03	2.703*
7	45.24	32.35	-1.144
Mean	31.63	35.50	.364
		SUPPER	
1	23.33	9.52	-1.273
2	19.51	70.00	4.275
3	19.23	40.74	1.705
4	30.00	38.71	.716
5	89.47	48.28	-3.706*
6	52.00	83.67	2.901*
7	17.65	35.71	1.617
Mean	35.88	46.66	0.839

*Significant at .05 level.

TABLE 7. NUMBER OF OBSERVATIONS BY MEALS OF INDIRECT WORK IN POSITIONS 70 AND 80 DURING PHASE A AND PHASE B.

Meal and Position	PHASE A Total	PHASE A Indirect Work for Positions 70 and 80		PHASE B Total	PHASE B Indirect Work for Positions 70 and 80	
	(No.)	(No.)	(%)	(No.)	(No.)	(%)
Breakfast	203			296		
Pos. 70		132	65.02		135	45.61
Pos. 80		31	15.27		99	33.45
Other Positions		40	19.71		62	20.94
Dinner	157			322		
Pos. 70		47	29.94		94	29.19
Pos. 80		52	33.12		147	45.65
Other Positions		58	36.94		81	25.16
Supper	165			285		
Pos. 70		81	49.09		76	26.67
Pos. 80		30	18.18		100	35.09
Other Positions		54	32.72		109	38.24

individual also recorded the number of trays which were diverted to the correction table. These trays were classified into two groups: (1) modified diet trays which were identified by a red tag and were diverted only to be rechecked for accuracy in accordance with the prescription for that tray, and (2) those trays which were known to need either correction or additional items.

Findings indicated that from 10.82 per cent to 25.99 per cent of the trays were diverted to the correction table. The mean proportion of trays diverted was 19.17 per cent or nearly one-fifth of all trays assembled (Table 8). The data also showed that a mean of 18.67 per cent of all diverted trays were diverted only for the double checking. All other diverted trays needed correction or additions. The reasons may have been due to (1) carelessness by the operators on the tray assembly, (2) inaccurate production sheets, (3) inability of the runner or production personnel to keep pace with tray assembly needs, or (4) a lack of an understanding by operators of the importance of working as a team in tray assembly.

4.2 Labor Time and Cost

A second objective of this study was to compare two patterns of patient trayline assembly in terms of labor time and labor costs. Input data was punched on IBM cards and verified for the computer program. Data cards included the code numbers for the operator, the position, the meal and day, the total hours expended in that position by that operator, and the pay rate of the operator.

Data output from the computer listed labor time expended and labor costs for each position for each meal during Phase A and Phase B. Totals for all positions for each meal were also computed. Total time and cost for each position during Phase A and Phase B were included in the output data.

Labor Time Analysis

Statistical analysis utilized a *t* test to determine if there was

TABLE 8. TOTAL TRAYS SERVED, TOTAL DIVERTED TRAYS, AND DIVERTED TRAYS WHICH WERE RECHECKED BUT NEEDED NO CORRECTION OR ADDITIONS

PHASE B

Day	Total Trays Served	Total Diverted Trays		Diverted Trays not Needing Correction	
	(No.)	(No.)	(%)	(No.)	(%)
		BREAKFAST			
1	282	67	23.75	27	40.30
2	298	64	21.47	10	15.63
3	298	73	24.50	6	8.22
4	318	67	21.07	15	22.39
5	319	61	19.12	15	24.59
6	319	62	19.44	11	17.74
7	303	58	19.14	21	36.21
Total	2137	452		105	
Mean	305	65	21.18	15	23.58
		DINNER			
1	312	77	24.68	19	24.68
2	304	79	25.99	5	6.33
3	305	62	20.33	7	11.29
4	344	62	18.02	3	4.84
5	340	55	16.18	9	16.36
6	325	53	16.31	16	30.19
7	279	50	17.92	14	28.00
Total	2209	438		73	
Mean	316	63	19.80	10	17.38
		SUPPER			
1	325	50	15.38	7	14.00
2	343	62	18.08	10	16.13
3	347	71	20.46	10	14.08
4	349	42	12.03	2	4.76
5	330	37	11.21	6	16.22
6	342	78	10.82	18	23.08
7	301	47	15.61	8	17.02
Total	2328	387		61	
Mean	334	55	16.52	9	15.04

any significant difference in labor time expended between positions and between total meals served during Phase A and Phase B. Significance was calculated at the 0.05 level.

Positions showing no significant difference. Time expended by the operators for position 10 and for position 40 was not significantly different between Phase A and Phase B.

Positions expending more time in Phase B. Data showed significantly more time expended by operators in position 80 for tray assembly during Phase B than Phase A (Table 9). There were two breakfast meals during Phase A for which no operator was observed in position 80. More labor time was expended for this position during Phase B. However, this difference was not significant at the 0.05 level (Table 10). Data for the dinner tray assembly showed that there were 2 meals for which there was no operator for position 80 during Phase A, while, for Phase B, there was more than one operator for 5 of the 7 days. Thus, significantly more time was used for this position during Phase B (Table 11). Extra personnel were observed in position 80 for 2 of the supper meals during Phase B. The total time for all three meals of tray assembly operations was computed. Findings indicated (Table 9) that for position 80 only, there was significantly more time expended during Phase B.

The increase in time expended in position 80 during Phase B may have been due, in part, to a feeling of anxiety for efficiency of the trayline operation on the part of management personnel. It was observed that much of the operator's time for this position was spent in correcting and inspecting trays. The number of trays diverted for a second check and/or correction was not recorded during Phase A. There-

TABLE 9. LABOR TIME IN HOURS BY POSITION FOR DAILY TRAY ASSEMBLY DURING PHASE A AND PHASE B.

Position	SUNDAY		MONDAY		TUESDAY		WEDNESDAY		THURSDAY		FRIDAY		SATURDAY		TOTAL		MEAN	
	A (hrs)	B (hrs)	A (hrs)	B (hrs)	A (hrs)	B (hrs)	A (hrs)	B (hrs)	A (hrs)	B (hrs)	A (hrs)	B (hrs)	A (hrs)	B (hrs)	A (hrs)	B (hrs)	A (hrs)	B (hrs)
10	4.45	4.39	4.90	4.92	4.96	4.47	5.00	4.70	4.79	4.37	4.65	4.73	4.50	4.66	33.25	32.24	4.75	4.61
15	4.48	4.01	4.55	4.25	4.76	4.40	4.72	4.23	4.77	3.93	4.24	4.00	4.43	3.70	31.95	28.52	4.56	4.07*
20	4.70	3.86	5.00	4.32	4.85	4.02	4.83	4.10	3.75	4.02	4.49	4.18	4.43	3.77	32.05	28.27	4.58	4.04*
25	4.48	3.88	4.70	5.84	4.66	5.24	4.61	5.59	4.64	4.15	4.37	4.26	4.24	4.28	31.70	33.24	4.53	4.75
30	3.00	2.55	3.25	4.49	3.14	3.77	3.18	2.90	3.27	2.75	4.25	2.77	2.84	2.40	22.93	21.63	3.28	3.09
35	4.70	3.90	4.51	4.47	4.73	4.09	4.76	4.42	6.38	4.09	4.23	4.28	4.50	3.84	33.81	29.09	4.83	4.16
40	3.05	2.50	3.11	3.08	3.13	2.60	2.91	2.85	3.23	2.60	2.63	2.68	2.74	2.85	20.80	19.16	2.97	2.74
45	4.59	4.13	4.67	5.36	4.73	5.75	4.63	4.45	4.68	4.57	6.22	4.33	4.56	3.89	34.08	32.48	4.87	4.64
50	4.60	3.90	4.64	4.15	6.14	4.23	4.65	4.34	4.60	4.18	5.80	4.23	4.55	3.91	34.98	28.94	5.00	4.13*
55	4.74	4.00	4.95	4.51	5.04	4.32	4.93	4.52	4.90	4.18	4.90	4.40	4.56	3.90	34.02	29.83	4.86	4.26*
60	4.86	4.03	4.90	4.56	3.84	4.25	4.45	4.40	5.00	4.38	4.66	4.46	4.50	3.93	32.21	30.01	4.60	4.29
65	4.64	4.10	4.90	4.51	4.94	4.07	4.81	4.43	4.90	4.24	4.69	4.38	4.46	3.85	33.34	29.58	4.76	4.23
70	4.76	3.49	4.82	4.07	4.80	4.07	4.76	5.47	4.25	4.05	4.60	4.83	4.50	3.71	32.49	29.69	4.64	4.24
75	3.34	3.05	3.74	3.67	3.52	3.26	3.58	3.50	3.44	3.44	3.60	3.50	3.59	3.11	24.81	23.53	3.54	3.36*
80	1.63	6.00	4.22	4.14	2.63	5.42	5.38	4.93	3.29	6.42	2.78	5.49	5.50	6.04	25.43	38.44	3.63	5.49*
TOTAL	62.02	57.79	66.86	66.34	65.87	63.96	67.20	64.83	65.89	61.37	66.11	62.52	63.90	57.84	457.85	434.65	65.40	62.10*
MEAN	4.13	3.85	4.46	4.42	4.39	4.26	4.48	4.32	4.39	4.09	4.41	4.17	4.26	3.86	30.52	28.98		

*Significant at the 0.05 level.

TABLE 10. LABOR TIME IN HOURS BY POSITION FOR BREAKFAST TRAY ASSEMBLY DURING PHASE A AND PHASE B.

Position	SUNDAY (hrs)		MONDAY (hrs)		TUESDAY (hrs)		WEDNESDAY (hrs)		THURSDAY (hrs)		FRIDAY (hrs)		SATURDAY (hrs)		TOTAL (hrs)		MEAN (hrs)	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
10	1.52	1.52	1.60	1.52	1.75	1.63	1.60	1.50	1.63	1.47	1.75	1.58	1.62	1.85	11.47	11.07	1.64	1.58
15	1.37	1.38	1.48	1.32	1.70	1.43	1.60	1.35	1.57	1.45	1.70	1.45	1.57	1.28	10.99	9.66	1.57	1.38*
20	1.53	1.43	1.55	1.40	1.62	1.42	1.68	1.35	1.70	1.43	1.77	1.40	1.68	1.40	11.53	9.83	1.65	1.40
25	1.43	1.38	1.60	1.27	1.68	1.47	1.62	1.27	1.62	1.35	1.75	1.43	1.55	1.33	11.25	9.50	1.61	1.36*
35	1.45	1.45	1.50	1.32	1.58	1.42	1.63	1.47	3.15	1.42	1.28	1.48	1.55	1.32	12.14	9.88	1.73	1.41
45	1.27	1.43	1.47	2.29	1.58	2.97	1.53	1.42	1.35	1.35	3.45	1.48	1.50	1.40	12.15	12.34	1.74	1.76
50	1.27	1.28	1.52	1.05	1.62	1.43	1.43	1.42	1.45	1.38	1.68	1.35	1.60	1.40	10.57	9.31	1.51	1.33*
55	1.48	1.37	1.58	1.32	1.77	1.62	1.67	1.48	1.65	1.48	1.83	1.58	1.60	1.40	11.58	10.25	1.65	1.46*
60	1.52	1.35	1.55	1.35	1.70	1.55	1.65	1.40	1.58	1.55	1.73	1.53	1.60	1.43	11.33	10.16	1.62	1.45*
65	1.45	1.45	1.55	1.40	1.73	1.48	1.63	1.38	1.62	1.47	1.75	1.53	1.67	1.42	11.40	10.13	1.63	1.45*
70	1.45	1.37	1.57	1.33	1.72	1.45	1.63	1.27	1.45	1.38	1.75	1.43	1.63	1.37	11.20	9.60	1.60	1.37*
75	1.17	1.02	1.17	1.05	1.20	1.02	1.27	1.20	1.17	1.17	1.47	1.25	1.23	1.13	8.68	7.84	1.24	1.12*
80	0.00	1.12	1.43	1.23	1.13	1.27	2.79	1.43	1.39	1.32	0.00	1.52	1.50	2.67	8.24	10.56	1.18	1.51
TOTAL	16.91	17.55	19.57	17.85	20.78	20.16	21.73	17.94	21.33	18.22	21.91	19.01	20.30	19.40	142.53	130.13	20.37	18.58*
MEAN	1.30	1.35	1.51	1.37	1.60	1.55	1.67	1.38	1.64	1.40	1.69	1.46	1.56	1.49	10.96	10.00		

*Significant at the 0.05 level.

TABLE 11. LABOR TIME IN HOURS BY POSITION FOR DINNER TRAY ASSEMBLY DURING PHASE A AND PHASE B.

Position	SUNDAY		MONDAY		TUESDAY		WEDNESDAY		THURSDAY		FRIDAY		SATURDAY		TOTAL		MEAN	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
	(hrs)		(hrs)		(hrs)		(hrs)		(hrs)		(hrs)		(hrs)		(hrs)		(hrs)	
10	1.30	1.50	1.58	1.55	1.68	1.42	1.82	1.67	1.53	1.53	1.55	1.47	1.50	1.33	10.96	10.47	1.57	1.50
15	1.48	1.40	1.42	1.43	1.63	1.42	1.57	1.58	1.53	1.33	1.37	1.37	1.48	1.27	10.48	9.80	1.50	1.40
20	1.60	1.33	1.73	1.37	1.68	1.45	1.63	1.40	1.35	1.47	1.50	1.33	1.45	1.22	10.94	9.57	1.56	1.37*
25	1.52	1.30	1.50	1.42	1.53	1.37	1.62	1.62	1.50	1.50	1.42	1.30	1.47	1.22	10.56	9.73	1.51	1.39
30	1.50	1.40	1.48	2.87	1.62	2.64	1.63	1.52	1.60	1.57	2.95	1.32	1.42	1.17	12.20	12.49	1.74	1.78
35	1.63	1.28	1.48	1.40	1.68	1.40	1.58	1.57	1.53	1.47	1.48	1.30	1.50	1.22	10.88	9.64	1.55	1.38*
40	1.50	1.37	1.38	1.35	1.65	1.37	1.48	1.55	1.50	1.45	1.40	1.23	1.37	1.12	10.28	9.44	1.47	1.35
45	1.60	1.33	1.48	1.42	1.65	1.50	1.60	1.60	1.53	1.47	1.47	1.33	1.58	1.22	10.91	9.87	1.56	1.41*
50	1.63	1.35	1.37	1.43	3.04	1.52	1.60	1.60	1.50	1.55	2.85	1.35	1.50	1.23	13.49	10.03	1.93	1.43
55	1.63	1.38	1.57	1.52	1.72	1.42	1.68	1.65	1.52	1.48	1.49	1.32	1.53	1.25	11.14	10.02	1.59	1.43*
60	1.60	1.40	1.57	1.53	1.67	1.45	1.23	1.58	1.60	1.53	1.55	1.43	1.53	1.25	10.75	10.17	1.53	1.45
65	1.62	1.33	1.57	1.48	1.68	1.42	1.60	1.60	1.58	1.52	1.52	1.33	1.40	1.20	10.97	9.88	1.57	1.41*
70	1.68	1.37	1.57	1.27	1.70	1.37	1.65	2.80	1.15	1.45	1.53	1.30	1.50	1.17	10.78	10.73	1.54	1.53
75	1.00	1.25	1.10	1.40	1.40	1.22	1.23	1.25	1.15	1.37	1.20	1.13	1.23	1.05	8.31	8.67	1.19	1.24
80	0.00	2.09	1.47	1.38	0.00	2.88	1.60	2.20	1.43	3.88	1.55	2.62	1.43	1.13	7.48	16.18	1.07	2.31*
TOTAL	21.29	21.08	22.27	22.82	24.33	23.85	23.52	25.19	22.00	24.57	24.83	21.13	21.89	18.05	160.13	156.69	22.88	22.38
MEAN	1.42	1.41	1.48	1.52	1.62	1.62	1.57	1.68	1.47	1.64	1.65	1.41	1.46	1.20*	10.68	10.44		

*Significant at the 0.05 level.

fore it is not known whether there were a significantly different number of trays in this category during Phase B which would have influenced the labor time expended for this position.

In position 25 there was on-the-job training for 3 of the supper meals during Phase B. This meant that more time was expended for that position for the supper meal during Phase B. The difference was not significant at the 0.05 level (Table 12).

Positions expending less time in Phase B. For the breakfast tray assembly operation 13 positions were used. The t tests calculated for each position indicated that 8 of the 13 positions expended significantly less time during Phase B than during Phase A. Total time expended for the breakfast tray assembly operation was also significantly less for Phase B (Table 10).

When a t test was applied to determine if there was any significant difference between days of the total breakfast tray assembly operation, findings showed significantly less labor time expended for Wednesday breakfast during Phase B. This was reflected in the increase in rate of trays per minute for Wednesday breakfast during Phase B (Table 13).

Both the dinner and supper tray assembly operations required operators in 15 positions. Data showed that 6 of these positions for the dinner meal (Table 11) and 4 of the positions for the supper meal (Table 12) expended significantly less time during Phase B. The reason for significantly less time to be expended in some positions and not in others cannot be explained.

The t test was utilized to determine significant differences

TABLE 12. LABOR TIME IN HOURS BY POSITION FOR SUPPER TRAY ASSEMBLY DURING PHASE A AND PHASE B.

Position	SUNDAY		MONDAY		TUESDAY		WEDNESDAY		THURSDAY		FRIDAY		SATURDAY		TOTAL		MEAN	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
	(hrs)		(hrs)		(hrs)		(hrs)		(hrs)		(hrs)		(hrs)		(hrs)		(hrs)	
10	1.63	1.37	1.72	1.85	1.53	1.42	1.58	1.53	1.63	1.37	1.35	1.68	1.38	1.48	10.82	10.70	1.55	1.53
15	1.63	1.23	1.65	1.50	1.43	1.15	1.55	1.30	1.67	1.15	1.17	1.18	1.38	1.15	10.48	8.66	1.50	1.24*
20	1.57	1.10	1.72	1.55	1.55	1.15	1.52	1.35	1.70	1.12	1.22	1.45	1.30	1.15	10.58	8.87	1.51	1.27
25	1.53	1.20	1.60	3.15	1.43	2.40	1.37	2.70	1.52	1.30	1.20	1.53	1.22	1.73	9.87	14.01	1.41	2.00
30	1.50	1.15	1.77	1.62	1.52	1.13	1.55	1.38	1.67	1.18	1.30	1.45	1.42	1.23	10.73	9.14	1.53	1.36*
35	1.62	1.17	1.53	1.75	1.47	1.27	1.55	1.38	1.70	1.20	1.47	1.50	1.45	1.30	10.79	9.57	1.54	1.37
40	1.55	1.13	1.73	1.73	1.48	1.23	1.43	1.30	1.73	1.15	1.23	1.45	1.37	1.73	10.52	9.72	1.50	1.39
45	1.72	1.37	1.72	1.65	1.50	1.28	1.50	1.43	1.80	1.75	1.30	1.52	1.48	1.27	11.02	10.27	1.57	1.47
50	1.70	1.27	1.75	1.67	1.48	1.28	1.62	1.32	1.65	1.25	1.27	1.53	1.45	1.28	10.92	9.60	1.56	1.37
55	1.63	1.25	1.80	1.67	1.55	1.28	1.58	1.37	1.73	1.22	1.58	1.50	1.43	1.25	11.30	9.54	1.61	1.36*
60	1.68	1.28	1.78	1.68	1.47	1.25	1.57	1.42	1.82	1.30	1.38	1.50	1.47	1.25	11.17	9.68	1.60	1.38*
65	1.57	1.32	1.78	1.63	1.53	1.17	1.58	1.45	1.70	1.25	1.42	1.62	1.43	1.28	11.01	9.72	1.57	1.39
70	1.63	.75	1.68	1.47	1.38	1.25	1.48	1.40	1.65	1.22	1.32	2.10	1.37	1.17	10.51	9.36	1.50	1.34
75	1.17	.82	1.47	1.12	.92	1.02	1.08	1.05	1.12	.90	.93	1.12	1.13	.93	7.82	6.96	1.12	.99
80	1.63	2.79	1.32	1.53	1.50	1.27	.99	1.30	.47	1.22	1.23	1.35	2.57	2.24	9.71	11.70	1.39	1.67
TOTAL	23.76	19.20	25.02	25.57	21.74	19.55	21.95	21.68	23.56	18.58	19.37	22.48	21.85	20.44	157.25	147.50	22.46	21.08
MEAN	1.58	1.28	1.67	1.70	1.45	1.30	1.46	1.45	1.57*	1.24	1.29	1.50	1.46	1.36	10.48	9.83		

*Significant at the 0.05 level.

TABLE 13. LABOR TIME EXPENDED, NUMBER OF TRAYS SERVED AND TRAY RATE PER MINUTE DURING PHASE A AND PHASE B

	PHASE A			PHASE B		
Day	Time	Total Trays Served	Tray Rate per Minute	Time	Total Trays Served	Tray Rate per Minute
	(Hrs.)	(No.)		(Hrs.)	(No.)	
			BREAKFAST			
1	16.89	328	4.28	17.54	282	3.53
2	19.56	332	4.15	17.83	298	4.40
3	20.78	356	4.06	20.14	298	3.78
4	21.73	355	3.99	17.93	318	4.30
5	21.31	336	4.08	18.21	319	4.50
6	21.91	324	3.43	19.03	319	4.36
7	20.29	329	3.94	19.39	303	4.10
Total	142.47	2360		130.07	2137	
Mean	20.35	337	3.99	18.58	305	4.14
			DINNER			
1	21.29	340	3.88	21.08	312	4.44
2	22.26	330	4.28	22.81	304	3.93
3	24.33	395	4.43	23.79	305	4.13
4	23.53	385	4.29	25.18	344	4.10
5	22.01	365	4.45	24.54	340	4.40
6	24.81	351	4.26	21.13	325	4.73
7	21.89	341	4.13	18.03	279	4.00
Total	160.12	2510		156.56	2209	
Mean	22.87	359	4.25	22.65	316	4.25
			SUPPER			
1	23.76	370	4.20	19.18	325	4.69
2	25.01	384	4.26	25.56	343	4.10
3	21.74	420	5.02	19.54	347	5.15
4	21.94	384	4.68	21.68	349	4.60
5	23.54	370	3.89	18.56	330	5.10
6	19.36	334	4.51	22.46	342	4.24
7	21.84	350	4.51	20.44	301	4.24
Total	163.29	2612		147.42	2328	
Mean	23.33	373	4.44	21.06	334	4.59

between the total time expended in all positions for the breakfast, dinner, and supper tray assembly operations. The total tray assembly operation time was significantly less for breakfast during Phase B (Table 10). For the dinner tray assembly there was significantly less time expended on Saturday during Phase B (Table 11). For the supper tray assembly operation there was significantly less time expended on Sunday and on Thursday during Phase B. The reason for this is not clear since the rate of trays per minute was higher for Thursday supper during Phase B than during Phase A but for the Sunday supper meal there was very little difference in the rate of trays per minute (Table 13).

Total time expended by operators for each position for all three meals of each day was compiled. The t test applied at the 0.05 level for the three meals showed a significantly smaller amount of time expended during Phase B than Phase A for 6 positions (Table 13). Some of the positions in which there was no significant difference were positions for which there was more than one operator for one or more meals during Phase B.

Data showed that there was a significant difference in time expended in tray assembly for the total Saturday tray assembly operation. There was no significant difference for the other six days. The reasons for this difference are not known. There were fewer trays assembled on Saturday during Phase B but there were also fewer trays assembled during Phase B on several other days. The schedule did not show more relief personnel on Saturday during Phase A. In fact, no pattern of regular and relief personnel over all positions was found.

Labor Cost Analysis

One set of IBM data cards for the computer program consisted of employee code numbers and pay rates for that employee. All trayline personnel employed during Phase A retained the same pay rate during Phase B for purposes of the study. Computer printout listed labor costs for each position for each meal and the cost of tray assembly for all positions by meal and for each day.

The t test was employed to determine if there was any significant difference in labor costs between Phase A and Phase B in (1) positions, (2) total tray assembly operation, and (3) trays served for breakfast, dinner, and supper.

Positions showing no significant difference. Labor costs for positions 10, 35, and 45 were not significantly different between Phase A and Phase B (Table 14).

Positions showing greater labor cost in Phase B. For position 25, where on-the-job training took place on 3 supper tray assembly operations during Phase B, there was a significant increase in labor cost during Phase B. Labor cost was also greater during Phase B than Phase A for position 40 for the supper meal. The cause of this is not known. The difference was not significant at the 0.05 level (Table 15).

Position 80 was vacant for two breakfast tray assembly operations during Phase A, while during Phase B there was an operator for this position for all breakfast meals and more than one operator for one breakfast meal. The t test results showed no significant difference in labor cost for this position for the breakfast meal (Table 16). However, for the dinner meal there was a significant increase in labor

TABLE 14. DAILY AND TOTAL LABOR COST BY POSITION FOR PATIENT TRAY ASSEMBLY DURING PHASE A AND PHASE B.

Position	SUNDAY A	SUNDAY B	MONDAY A	MONDAY B	TUESDAY A	TUESDAY B	WEDNESDAY A	WEDNESDAY B	THURSDAY A	THURSDAY B	FRIDAY A	FRIDAY B	SATURDAY A	SATURDAY B	TOTAL A	TOTAL B	MEAN A	MEAN B
10	$6.96	$7.78	$8.71	$8.61	$8.82	$7.91	$8.86	$8.32	$8.46	$7.75	$8.35	$8.32	$8.13	$8.26	$58.29	$56.95	$8.33	$8.14
15	6.87	6.30	7.82	7.32	8.34	7.02	8.34	7.52	8.22	7.00	7.70	7.47	7.77	5.80	55.06	48.43	7.87	6.92*
20	8.30	5.80	8.91	7.58	8.82	7.51	8.57	7.42	8.34	7.18	8.03	7.53	6.64	5.99	57.61	49.01	8.23	7.00*
25	7.25	7.45	8.21	9.64	8.19	9.15	8.49	9.71	8.12	6.61	7.89	7.17	6.75	7.34	54.90	57.07	7.84	8.15
30	4.79	3.77	5.65	7.58	5.34	6.20	5.26	4.80	5.46	4.54	7.11	3.94	4.53	3.42	38.14	34.25	5.45	4.89
35	7.86	6.61	8.04	7.56	8.32	7.03	7.95	7.90	11.55	6.99	6.86	6.72	7.34	6.38	57.92	49.19	8.27	7.03
40	5.41	4.35	5.23	5.41	5.35	4.35	5.04	5.08	5.45	4.56	4.69	4.71	4.65	5.02	35.82	33.48	5.12	4.78
45	7.77	7.21	8.70	9.77	8.45	9.89	8.50	8.17	7.95	7.78	11.17	6.94	8.23	6.05	60.77	55.81	8.68	7.97
50	6.67	5.92	7.73	6.02	14.37	6.14	8.13	6.28	7.70	7.09	10.50	7.07	6.88	6.17	61.98	44.69	8.85	6.38
55	7.59	5.99	10.28	9.34	10.51	8.41	10.29	9.83	10.19	8.75	9.89	9.15	6.85	5.71	65.60	57.18	9.37	8.17*
60	9.39	8.08	11.84	11.05	11.54	10.14	9.93	9.54	11.16	9.54	11.05	10.42	8.83	8.13	73.74	66.90	10.53	9.56*
65	9.72	8.63	10.22	9.92	10.53	7.46	9.30	9.75	10.77	9.33	9.90	9.44	8.25	7.53	68.69	62.06	9.81	8.87
70	20.50	6.59	16.51	7.83	20.76	7.95	21.16	10.07	18.25	7.58	19.54	8.71	15.79	6.56	132.51	55.29	18.93	7.90*
75	6.39	5.67	6.95	6.83	6.73	6.13	6.81	6.70	6.59	6.53	6.94	6.64	9.94	5.86	50.32	44.36	7.19	6.34
80	3.43	26.71	15.11	17.85	4.63	19.44	13.69	21.62	7.95	24.17	5.15	19.99	17.49	19.58	67.45	149.36	9.64	21.34*
TOTAL	118.90	116.86	139.91	132.31	142.70	124.73	140.32	132.71	136.16	125.40	134.77	124.22	128.07	107.80	938.80	864.03	134.11	123.44*
MEAN	7.93	7.79	9.33	8.82	9.38	8.32	9.35	8.85	9.08	8.36	8.98	8.28	8.54	7.19	62.59	57.60		

*Significant at the 0.05 level.

TABLE 15. LABOR COST BY POSITION FOR SUPPER TRAY ASSEMBLY DURING PHASE A AND PHASE B.

Position	SUNDAY A	SUNDAY B	MONDAY A	MONDAY B	TUESDAY A	TUESDAY B	WEDNESDAY A	WEDNESDAY B	THURSDAY A	THURSDAY B	FRIDAY A	FRIDAY B	SATURDAY A	SATURDAY B	TOTAL A	TOTAL B	MEAN A	MEAN B
10	$2.45	$2.05	$2.66	$2.77	$2.30	$2.12	$2.37	$2.30	$2.45	$2.05	$2.09	$2.52	$2.21	$2.22	$16.53	$16.03	$2.36	$2.29
15	2.45	1.85	2.31	2.10	2.01	1.61	2.17	1.95	2.33	1.72	1.87	2.12	2.07	1.72	15.21	13.07	2.17	1.87*
20	2.35	1.65	3.00	2.32	2.71	2.07	2.27	2.02	2.55	1.67	1.82	2.61	1.95	2.07	16.65	14.41	2.38	2.06
25	2.22	2.28	2.32	5.11	2.08	3.90	2.19	4.39	2.20	2.27	1.74	2.68	2.01	3.03	14.76	23.66	2.11	3.38*
30	2.32	1.67	2.83	2.42	2.43	1.64	2.32	2.07	2.58	1.72	1.95	2.10	2.12	1.79	16.55	13.41	2.36	1.92*
35	2.42	1.87	2.45	2.80	2.20	2.03	2.48	2.21	2.72	1.80	2.20	2.25	2.17	1.95	16.64	14.91	2.38	2.13
40	2.56	2.10	2.60	3.12	2.22	2.03	2.22	2.14	2.60	1.95	2.03	2.61	2.53	3.12	16.76	17.07	2.39	2.44
45	3.09	2.46	3.09	2.97	2.47	1.92	2.70	2.58	2.61	3.15	2.34	2.27	2.67	1.90	18.97	17.25	2.71	2.46
50	2.46	1.84	2.54	2.42	2.45	1.86	2.67	1.91	2.39	1.81	1.84	2.22	2.39	1.86	16.74	13.92	2.39	1.99*
55	2.45	1.87	3.51	3.25	3.02	2.50	3.09	2.66	3.38	2.37	3.09	2.92	2.15	1.87	20.69	17.44	2.96	2.49*
60	4.56	3.48	4.83	4.56	3.97	3.39	3.45	2.83	4.00	2.60	3.75	4.06	3.97	3.39	28.53	24.31	4.08	3.47*
65	2.82	2.37	3.21	3.43	2.84	2.10	3.32	3.04	3.57	2.62	2.55	2.99	2.58	2.69	20.89	19.24	2.98	2.75
70	7.37	1.46	7.05	2.64	6.09	2.62	6.53	2.52	7.26	2.19	5.79	3.87	2.32	2.10	42.41	17.40	6.06	2.49*
75	2.27	1.59	2.64	2.18	1.79	1.98	2.06	2.05	2.19	1.71	1.87	2.12	2.04	1.82	14.86	13.45	2.12	1.92
80	3.43	12.42	5.94	6.75	2.70	5.57	1.82	5.85	.91	5.35	2.28	5.66	8.29	6.62	25.37	48.20	3.62	6.89*
TOTAL	45.22	40.96	50.98	48.84	41.28	37.34	41.66	40.52	43.74	34.98	37.21	43.00	41.47	38.15	301.56	283.77	43.08	40.55
MEAN	3.01	2.73	3.40	3.26	2.75	2.49	2.78	2.70	2.92	2.33	2.48	2.87	2.76	2.54	20.11	18.93		

*Significant at the 0.05 level.

TABLE 16. LABOR COST BY POSITION FOR BREAKFAST TRAY ASSEMBLY DURING PHASE A AND PHASE B.

Position	SUNDAY A	SUNDAY B	MONDAY A	MONDAY B	TUESDAY A	TUESDAY B	WEDNESDAY A	WEDNESDAY B	THURSDAY A	THURSDAY B	FRIDAY A	FRIDAY B	SATURDAY A	SATURDAY B	TOTAL A	TOTAL B	MEAN A	MEAN B
10	$2.43	$2.88	$3.04	$2.88	$3.32	$3.10	$3.04	$2.85	$3.10	$2.79	$3.32	$3.01	$3.07	$3.51	$21.32	$21.02	$3.05	$3.00
15	2.12	2.21	2.82	2.50	3.23	2.72	3.12	2.56	2.98	2.75	3.23	2.75	2.98	2.05	20.48	17.54	2.93	2.51*
20	2.91	2.15	2.79	2.66	2.91	2.69	3.20	2.56	3.23	2.72	3.36	2.52	2.52	2.10	20.92	17.40	2.99	2.49*
25	2.15	2.70	3.04	2.41	3.20	2.79	3.07	2.41	3.07	2.02	3.32	2.15	2.32	2.00	20.17	16.48	2.88	2.35*
35	2.75	2.39	2.85	2.24	3.01	2.41	3.10	2.79	5.99	2.70	1.92	2.52	2.40	2.24	22.02	17.29	3.15	2.47
45	2.28	2.15	2.79	4.11	2.85	5.12	2.76	2.55	2.43	2.43	6.04	2.67	2.55	1.96	21.70	20.99	3.10	3.00
50	1.84	1.99	2.73	1.52	2.91	2.08	2.58	2.05	2.61	2.49	3.03	2.56	2.32	2.52	18.02	15.21	2.57	2.17
55	2.45	2.05	3.40	2.83	3.80	3.15	3.58	3.19	3.55	3.19	3.94	3.40	2.40	2.03	23.12	19.84	3.30	2.83*
60	2.35	2.43	3.49	3.04	3.82	3.49	3.71	3.15	3.56	3.49	3.90	3.45	2.48	2.22	23.31	21.27	3.33	3.04*
65	3.26	3.26	3.49	3.15	3.90	2.74	3.02	3.11	3.64	3.30	3.94	3.45	3.08	2.62	24.33	21.63	3.48	3.09*
70	6.08	2.60	2.90	2.53	7.19	2.46	7.37	2.15	6.08	2.35	7.33	2.44	7.02	2.46	43.97	16.99	6.28	2.43*
75	2.22	1.83	2.22	1.99	2.28	1.83	2.41	2.28	2.22	2.22	2.79	2.37	2.34	2.15	16.48	14.67	2.35	2.10*
80	0.00	5.04	6.46	5.30	1.93	5.10	8.51	6.01	4.03	5.66	0.00	6.52	6.76	8.09	27.69	41.72	3.96	5.96
TOTAL	32.84	33.68	42.02	37.16	44.35	39.68	49.47	37.66	46.49	38.11	46.12	39.81	42.24	35.95	303.54	262.04	43.36	37.44*
MEAN	2.53	2.59	3.23	2.86	3.41	3.05	3.81	2.90*	3.58	2.93	3.55	3.06	3.25	2.77	23.35	20.16		

*Significant at the 0.05 level.

cost during Phase B over Phase A. This was because this position was not filled for two dinner tray assembly operations during Phase A but for Phase B the position had at least one operator for each meal and for 5 of the 7 dinner meals there was more than one operator (Table 17).

For the supper tray assembly there was consistently more labor cost for position 80 during Phase B (Table 15). The mean difference in cost for this position during Phase B was nearly twice that for Phase A (47.38 per cent greater).

Personnel for this position and for position 70 were most often management or supervisory personnel. The pay rates of operators for these positions were generally higher than those for operators in other positions. This meant that extra personnel for these positions represented a greater increase in labor cost than did extra personnel for the other positions.

Positions showing less labor cost in Phase B. For the breakfast tray assembly operation the positions for which there was a significant difference in labor cost closely paralleled those for which there was also a significant difference in labor time. Table 16 shows 8 positions for the breakfast meal for which there was significantly less labor cost during Phase B. Position 20 showed significantly less cost but not significantly less labor time. This was partially due to relief personnel on a lower pay rate for two days during Phase B. Position 50 showed significantly less labor time and less labor cost, but not significantly less, during Phase B. The employee schedules did not explain this difference. In all other instances those positions for which there was less

labor time expended there was also less labor cost utilized in operating that position for the breakfast meal.

Of the 15 positions in operation for the dinner and supper tray assembly operation 6 positions showed a significant decrease in labor cost during Phase B for the dinner meal (Table 17) and 8 positions showed a significant decrease in labor cost for the supper meal (Table 15). The reasons some positions showed a significant decrease in labor costs and others did not cannot be explained.

Total Tray Assembly Labor Cost

Total labor cost for the breakfast tray assembly, when averaged over positions, showed a significant reduction in labor cost during Phase B. When total labor cost for the breakfast meals for each day were compared no significant difference was found except for the one meal of Wednesday breakfast (Table 16). No significant difference was found for the dinner and supper meals either when averaged over positions or when total labor cost for meals was compared.

Total daily labor costs were computed. Findings from statistical tests showed significantly less labor cost during Phase B when averaged over positions but when total daily labor costs were compared between Phase A and Phase B there was no significant difference (Table 14).

Labor Cost per Tray

The labor cost for each tray served through the system during Phase A and Phase B was computed for the breakfast, dinner and supper tray assembly operations. The range in cost per tray for Phase A was $0.098 to $0.146 and for Phase B it was $0.106 to $0.157 (Table 18).

TABLE 17. LABOR COST BY POSITION FOR DINNER TRAY ASSEMBLY DURING PHASE A AND PHASE B.

Position	SUNDAY A	SUNDAY B	MONDAY A	MONDAY B	TUESDAY A	TUESDAY B	WEDNESDAY A	WEDNESDAY B	THURSDAY A	THURSDAY B	FRIDAY A	FRIDAY B	SATURDAY A	SATURDAY B	TOTAL A	TOTAL B	MEAN A	MEAN B
10	$2.08	$2,85	$3.01	$2.94	$3.20	$2.69	$3.45	$3.17	$2.91	$2.91	$2.94	$2.79	$2.85	$2.53	$20.44	$19.88	$2.92	$2.84
15	2.30	2.24	2.69	2.72	3.10	2.69	3.05	3.01	2.91	2.53	2.60	2.60	2.82	2.03	19.47	17.82	2.78	2.55
20	3.04	2.00	3.12	2.60	3.20	2.75	3.10	2.66	2.56	2.79	2.85	2.40	2.17	1.82	20.04	17.02	2.86	2.43*
25	2.88	2.47	2.85	2.12	2.91	2.46	3.23	2.91	2.85	2.32	2.83	2.34	2.42	2.31	19.97	16.93	2.85	2.42*
30	2.47	2.10	2.82	5.16	2.91	4.56	2.94	2.73	2.88	2.82	5.16	1.84	2.41	1.63	21.59	20.84	3.08	2.98
35	2.69	2.35	2.74	2.52	3.11	2.59	2.37	2.90	2.84	2.49	2.74	1.95	2.77	2.19	19.26	16.99	2.75	2.43
40	2.85	2.25	2.63	2.29	3.13	2.32	2.82	2.94	2.85	2.61	2.66	2.10	2.12	1.90	19.06	16.42	2.72	2.34*
45	2.40	2.60	2.82	2.69	3.13	2.85	3.04	3.04	2.91	2.20	2.79	2.00	3.01	2.19	20.10	17.57	2.89	2.51
50	2.37	2.09	2.46	2.08	9.01	2.20	2.88	2.32	2.70	2.79	5.63	2.29	2.17	1.79	27.22	15.56	3.89	2.22
55	2.69	2.07	3.37	3.26	3.69	2.76	3.62	3.55	3.26	3.19	2.86	2.83	2.30	1.81	21.79	19.47	3.11	2.78*
60	2.48	2.17	3.52	3.45	3.75	3.26	2.77	3.56	3.60	3.45	3.49	3.22	2.38	1.94	21.99	21.05	3.14	3.01
65	3.64	3.00	3.52	3.34	3.79	2.62	2.96	3.60	3.56	3.41	3.41	3.00	2.59	2.22	23.47	21.19	3.35	3.03
70	7.05	2.53	6.56	2.66	7.48	2.87	7.26	5.40	4.91	3.04	6.42	2.40	6.45	2.00	46.13	20.90	6.59	2.98*
75	1.90	2.25	2.09	2.66	2.66	2.32	2.34	2.37	2.18	2.60	2.28	2.15	5.56	1.89	19.01	16.24	2.72	2.32
80	0.00	9.25	2.71	5.80	0.00	8.77	3.36	9.76	3.01	13.16	2.87	7.81	2.44	4.87	14.39	59.42	2.06	8.49*
TOTAL	40.84	42.22	46.91	46.29	55.07	47.71	49.19	53.92	45.93	52.31	51.53	41.72	44.46	33.12	333.93	317.29	47.70	45.33
MEAN	2.72	2.81	3.13	3.09	3.67	3.18	3.28	3.59	3.06	3.49	3.44	2.78	2.96	2.21	22.27	21.16		

*Significant at the 0.05 level.

TABLE 18. TOTAL TRAYS SERVED, LABOR COST, AND LABOR COST PER TRAY FOR BREAKFAST, DINNER AND SUPPER DURING PHASE A AND PHASE B

Day	PHASE A			PHASE B		
	Trays Served	Labor Cost	Cost per Tray	Trays Served	Labor Cost	Cost per Tray
	(No.)			(No.)		
			BREAKFAST			
1	328	$ 32.84	$0.100	282	$ 33.68	$0.119
2	332	42.02	0.127	298	37.16	0.125
3	356	44.35	0.125	298	39.68	0.133
4	355	49.47	0.139	318	37.66	0.118
5	336	46.49	0.138	319	38.11	0.119
6	324	46.12	0.142	319	39.11	0.123
7	329	44.24	0.130	303	35.95	0.119
Total	2360	303.53	0.901	2137	261.35	0.856
Mean	337	43.36	0.129	305	37.34	0.122
			DINNER			
1	340	$ 40.84	$0.120	312	$ 42.22	$0.135
2	330	46.91	0.142	305	46.29	0.152
3	395	55.07	0.139	305	47.71	0.156
4	385	49.19	0.128	344	53.92	0.157
5	365	45.93	0.126	340	52.31	0.154
6	354	51.53	0.146	325	41.72	0.128
7	341	44.46	0.130	279	33.12	0.119
Total	2510	333.93	0.931	2209	317.29	1.001
Mean	359	47.70	0.133	316	45.33	0.143
			SUPPER			
1	370	$ 45.22	$0.122	325	$ 40.96	$0.126
2	384	50.98	0.133	343	48.84	0.142
3	420	41.28	0.098	347	37.34	0.108
4	384	41.66	0.108	349	40.52	0.116
5	370	43.74	0.112	330	34.98	0.106
6	334	37.21	0.111	342	43.00	0.126
7	350	41.47	0.118	301	38.15	0.127
Total	2612	301.56	0.802	2328	283.79	0.851
Mean	373	43.08	0.115*	334	40.54	0.122*

*Significant at the 0.05 level.

It was interesting to note that the lowest cost per tray did not occur at the meal with the least number of trays served. Findings from application of the t test showed that the cost per tray for the breakfast and dinner meals was not significantly different, but there was a significant increase in labor cost during Phase B for the supper meal. Data reported in Table 14 indicate that there was consistently more labor cost for position 80 during Phase B since the pay rates of operators in this position represented management or supervisory personnel.

4.3 Productivity Index

The third stated objective of this study was to test the null hypothesis that no significant differences exist between the productivity index of the tray assembly operation during Phase A and Phase B.

The productivity index of the tray assembly operation is output from the system in rate of trays per minute. The rate was obtained by dividing the number of trays going through the system by the time expended in the operation for that meal.

The t test was utilized to test the null hypothesis that there was no significant difference between Phase A and Phase B. Significance was at the 0.05 level. The null hypothesis was not rejected (Table 13).

The rate of trays per minute appeared to be influenced by several factors, (1) the efficiency of personnel in the tray assembly operation, (2) adequate and continuous amounts of foods and supplies at the operator positions, (3) proportion of modified diet trays served, and (4) number of trays diverted to the correction table.

It was felt that modified diet trays require more time and effort to assemble than other trays because of the necessity of looking for

individually labeled items, weighing some items while on the tray assembly line, and double checking those modified diet trays labeled with red tags. Table 19 shows that there was a significantly higher proportion of modified diet trays during Phase B than during Phase A. It was felt that this may have been one reason the rate of trays per minute was not significantly greater during Phase B.

It was felt that the liquid and nourishment trays may have influenced the rate of trays per minute because of the few items used for these trays and the ease in assemblying them. Table 20 (Appendix A) was compiled and a t test was utilized to determine whether there was any significant difference in the proportion of liquid and nourishment trays during Phase A and Phase B. It was found that there was no significant difference. It was felt, therefore, that this category of trays did not have any significant influence on the rate of trays per minute.

It was observed during Phase A and during the random sampling period following Phase A that the conveyor belt was stopped numerous times during the tray assembly period.

It seemed desirable to record the number of times the belt was not in operation during Phase B. Table 21 shows the number of times the conveyor belt was stopped during tray assembly.

Tray conveyor belt stoppage could be attributed to (1) inaccurate production schedules, (2) inattention of the runner, or (3) carelessness of the operators in missing items on the trays.

Since the number and proportion of trays diverted to the correction table during Phase A was not recorded, no comparison was possible.

TABLE 19. TOTAL TRAYS, MODIFIED DIET TRAYS AND RATE OF TRAYS PER MINUTE FOR THREE MEALS DURING PHASE A AND PHASE B

	PHASE A				PHASE B			
Day	Total Trays	Modified Diet Trays		Trays per Min.	Total Trays	Modified Diet Trays		Trays per Min.
	(No.)	(No.)	(%)		(No.)	(No.)	(%)	
				BREAKFAST				
1	328	95	28.96	4.28	282	120	42.56	3.53
2	332	90	27.11	4.15	298	114	38.26	4.40
3	356	97	27.53	4.06	298	105	35.23	3.78
4	355	95	26.76	3.99	318	121	38.05	4.30
5	336	93	27.68	4.08	319	122	38.24	4.50
6	324	90	27.78	3.43	319	109	34.17	4.36
7	329	90	27.36	3.94	303	104	34.32	4.10
Total	2360	650			2137	795		
Mean	337	93	27.60*	3.99	305	113	37.26*	4.14
				DINNER				
1	340	97	28.53	3.88	312	117	37.50	4.44
2	330	112	33.94	4.28	305	127	41.64	3.93
3	395	121	30.63	4.43	305	110	36.06	4.13
4	385	124	32.21	4.29	344	134	38.95	4.10
5	365	117	32.05	4.45	340	125	36.76	4.40
6	354	111	31.36	4.26	325	115	35.38	4.73
7	341	104	30.50	4.13	279	102	36.56	4.00
Total	2510	786			2209	830		
Mean	359	112	31.32*	4.25	316	119	37.55*	4.25
				SUPPER				
1	370	114	30.81	4.20	325	124	38.15	4.19
2	384	120	31.25	4.26	343	125	36.44	4.10
3	320	114	35.94	5.02	347	123	35.45	5.15
4	384	115	29.94	4.68	349	124	35.53	4.60
5	370	120	32.43	3.89	330	108	32.73	5.10
6	334	105	31.44	4.51	342	127	31.35	4.24
7	350	106	30.29	4.51	301	108	35.55	4.24
Total	2612	794			2328	839		
Mean	373	113	31.73*	4.44	334	120	35.03*	4.59

*Significant at the 0.05 level.

TABLE 21. TOTAL TRAYS, CORRECTED TRAYS, CONVEYOR BELT STOPPAGES, AND RATE OF TRAYS PER MINUTE DURING PHASE B

Day	Total Trays	Corrected Trays		Conveyor Belt Stoppages	Trays per Min.
	(No.)	(No.)	(%)	(No.)	
		BREAKFAST			
1	282	67	23.75	6	3.53
2	298	64	21.47	3	4.40
3	298	73	24.50	81	3.78
4	318	67	21.07	28	4.30
5	319	61	19.12	8	4.50
6	319	62	19.44	22	4.36
7	303	58	19.14	25	4.10
Total	2137	452		173	
Mean	305	65	21.18	25	4.14
		DINNER			
1	312	77	24.68	10	4.44
2	305	79	25.99	78	3.93
3	305	62	20.33	65	4.13
4	344	62	18.02	71	4.10
5	340	55	16.18	28	4.40
6	325	53	16.31	23	4.73
7	279	50	17.92	13	4.00
Total	2209	438		288	
Mean	316	63	19.80	41	4.25
		SUPPER			
1	325	50	15.38	6	4.69
2	343	62	18.08	15	4.10
3	347	71	20.46	25	4.15
4	349	42	12.03	5	4.60
5	330	37	11.21	8	5.10
6	342	78	10.82	12	4.24
7	301	47	15.61	7	4.24
Total	2328	387		78	
Mean	334	55	16.52	11	4.59

However, it was observed that the operators in positions 70 and 80 spent much time in the inspection and correction of diverted trays. One reason for the extra personnel observed for these positions during Phase B was the large proportion of trays needing correction or additions. It was observed that personnel in these positions were most often management or supervisory level. The pay rates for these individuals were substantially higher than for most of the other operators on the tray assembly operation.

It would seem advisable, in the interest of economy in the tray line assembly system, to identify the reasons for the large number of diverted trays and to reexamine the reasons for scheduling management level personnel for tray assembly position operators.

CHAPTER V

CONCLUSIONS, RECOMMENDATIONS AND SUMMARY

Systems analysis is one useful approach to identifying and defining the information required for management decisions about operations within food service systems. One of the primary objectives in food service systems is the minimization of labor input both quantitatively and qualitatively in terms of skill and total man-hours. Quantitative information may pinpoint operational problems and suggest some productive course of action when continuing clinical research of hospital food service operations can provide objective data for analyzing present methods of service for establishing standards.

A food service system within a hospital complex represents approximately 10 per cent of the total labor cost. Doyon (1970) indicated that labor costs are the largest single expense of the food service system. Therefore, it is essential that every effective measure possible be taken to increase productive labor time and minimize inefficiencies in manpower usage. Economic pressures have demanded that operation expenses within food systems be more carefully analyzed and controlled.

Tray assembly activities represent a subsystem of the total food system. Problems related to the patient tray assembly involve the interruptions in the flow of materials through the system, unequal division of work among the operators, per cent of modified to general

trays, and the number of times a tray is checked for accuracy. The need has become critical for food administrators to apply systems analysis to each subsystem.

5.1 Conclusions and Recommendations

Production facilities in hospital food systems have been upgraded more rapidly than systems of operations. Knowledge of a food system cannot be acquired through a mere accumulation of data; a systematic analysis of the methods, procedures and relationships existing within the system is necessary.

The method of analysis, work sampling, used in this research was a feasible measurement technique for making a quantitative evaluation of the distribution of labor time by position on trayline assembly. Labor time as well as the productivity index (trays per minute) were used to determine the measure of effectiveness of system performance. Labor cost by position was also computed since personnel paid at different wage rates were utilized as operators.

Input data to the computer program generated the proportion of work function activities for each position for each meal during Phase A and Phase B. Observations recorded during Phase A identified the work position content of each operator and the flow of trays per minute through the system.

Efficient operation of the patient tray assembly subsystem is a crucial part of the food service system because of the large amount of labor time and cost involved and the limited time available for tray service.

Changes made in trayline operations following Phase A included

(1) application of work simplification techniques for position 10 to increase the motion economy of the operator, (2) removal of one section of shelving above the conveyor belt to increase visibility of the menu, and (3) the scheduling of an operator to the runner position for the breakfast meal on the same basis as for the dinner and supper meals.

Labor Time Analysis

Significant differences at the 0.05 level were determined between the total time expended in all positions for the breakfast, dinner, and supper tray assembly operations. The total tray assembly operation time was significantly less for breakfast during Phase B. For the dinner tray assembly there was significantly less time expended during Phase B on only one day. Significantly less time was expended on the supper trayline for two days only during Phase B.

Total time expended by operators for all three meals of each day was significantly smaller during Phase B for 6 positions only. In some of the positions in which there was not a significant difference, data showed that there was more than one operator in the position for one or more meals during Phase B.

Labor Cost Analysis

Total labor cost for the breakfast tray assembly was significantly less during Phase B. Labor costs were significantly less in 8 positions. For the dinner and supper meal, no significant difference between Phase A and Phase B was found in total labor cost for each meal. Of the 15 positions utilized at both the dinner and supper tray assem-

bly, 5 positions at dinner and 6 positions at supper were significantly less in cost.

The labor cost for positions 70 and 80 was high for both Phase A and Phase B but was significantly higher during Phase B because of extra operators in these positions. Management and supervisory personnel were most often observed serving as operators. This meant that the extra hours expended in these two positions represented larger labor costs than in other positions due to the higher salaried skilled personnel involved. These operators were observed in indirect work activities, primarily instruction, for a large proportion of the time during both Phase A and Phase B.

The labor cost for each tray served through the system during Phase A and Phase B was computed for the breakfast, dinner, and supper tray assembly operations. Statistical analysis showed that the cost per tray for the breakfast and dinner meals was not significantly different, but there was a significant increase in labor cost per tray during Phase B for the supper meal.

The principal problem of the food service industry is the cost of labor (Hubbard, 1970). A study which could pinpoint inefficiencies in work distribution or in work methods should make possible the redistribution of work in positions and reduction of man-hours required. Reevaluation of the amount of skilled labor and the activities of these operators would be in the interest of a more economical operation of the tray assembly subsystem.

Productivity Index

The productivity index is an expression of the labor time expended

in relation to output, the rate of trays per minute through the system. Productivity is the key to expense control, and development of maximum productivity in individuals and entire systems is the greatest single factor in the success of that system (Groner, 1964).

No significant difference in the productivity index between Phase A and Phase B was found. The higher proportion of modified diet trays during Phase B may have been a factor. No other conclusion could be stated. However, the lack of significant improvement may also have been partially due to (1) untrained or careless operators, (2) number of diverted and corrected trays, (3) number of times the conveyor belt was stopped during the meal, or (4) the lack of supplies at the positions when needed.

The following recommendations suggested from this research were to: (1) continue work measurement studies to provide data for developing time and workload distribution standards for each position, (2) determine optimal labor requirements for positions 70 and 80 for the most effective manner to accomplish the function, (3) study the effects of the number of modified trays on the productivity index, and (4) implement and evaluate an employee training program.

It is further suggested that the problem solving approach be utilized continually in analyzing and evaluating present methods of service. Supervisory personnel trained for a specific role may be more effectively involved in the day-to-day training and development of subordinates. On-the-job experiences can be the most influential factor in the growth and motivation of people (Bennett, 1969). All food service personnel

should understand the goals and substance of the system or procedure of which their jobs are a part.

5.2 Summary

The purpose of this research was to determine through work sampling the proportion of labor time by position for each meal of the trayline assembly operation to establish normal service times representative of specific methods and procedures. Calculation of the rate of trays assembled per minute gave the productivity index. A hospital dietary service was used as the source of data.

During Phase A the activities which caused the changes in status as a trayline assembly progresses through time were observed. Findings suggested three procedural changes which could be implemented to test the effect on labor time involved. After the changes were effected, work function activities of trayline personnel were again observed, recorded and used as computer input data.

Labor time and labor cost during both Phase A and Phase B was compared statistically. No significant difference, at the 0.05 level, was found between total tray assembly time or total tray assembly costs between the two phases.

The productivity index for Phase A was not significantly different from Phase B. Findings from the study did not support the rejection of the hypothesis that no significant difference existed between the productivity index (trays per minute) during Phase A and Phase B.

All aspects of the production area of dietary service are oriented toward the tray assembly operation. The goal is to provide all items in quantity and quality desired at the proper time for trayline needs.

Further research could generate the data for developing production standards to provide measures of effectiveness in achieving desired objectives for trayline assembly. No major innovation will bring about a radical change: it is the sum total of these changes that counts. The challenge confronting food service administrators in a dynamic milieu is to be in a receptive mood for change, and be willing continually to question each operation. In these directions lies progress.

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APPENDIX A

DATA ON LIQUID AND NOURISHMENT TRAYS

TABLE 20. TOTAL TRAYS, LIQUID AND NOURISHMENT TRAYS AND RATE OF TRAYS PER MINUTE FOR THREE MEALS DURING PHASE A AND PHASE B

	PHASE A				PHASE B			
Day	Total Trays	Liquid & Nourishment Trays		Trays per Min.	Total Trays	Liquid & Nourishment Trays		Trays per Min.
	(No.)	(No.)	(%)		(No.)	(No.)	(%)	
				BREAKFAST				
1	328	33	10.06	4.28	282	26	9.22	3.53
2	332	33	9.94	4.15	298	33	11.07	4.40
3	356	39	10.96	4.06	298	26	8.72	3.78
4	355	40	11.27	3.99	318	29	9.12	4.30
5	336	33	9.82	4.08	319	29	9.09	4.50
6	324	26	8.02	3.43	319	33	10.34	4.36
7	329	32	9.73	3.94	303	30	9.90	4.10
Total	2360	235			2137	206		
Mean	337	34	9.69	3.99	305	29	9.64	4.14
				DINNER				
1	340	41	12.06	3.88	312	30	9.62	4.44
2	330	38	11.52	4.28	305	25	8.20	3.93
3	395	44	11.14	4.43	305	29	9.51	4.13
4	385	45	11.69	4.29	344	29	8.43	4.10
5	365	31	8.49	4.45	340	33	9.71	4.40
6	354	34	9.05	4.26	325	33	10.15	4.73
7	341	36	10.56	4.13	279	27	9.68	4.00
Total	2510	269			2209	206		
Mean	359	38	10.64	4.25	316	29	9.33	4.25
				SUPPER				
1	370	47	12.70	4.20	325	41	12.62	4.19
2	384	49	12.76	4.26	343	40	11.66	4.10
3	420	59	14.05	5.02	347	44	12.68	5.15
4	384	50	13.02	4.68	349	37	10.60	4.60
5	370	40	10.81	3.89	330	43	13.03	5.10
6	334	37	11.08	4.51	342	38	11.11	4.24
7	350	42	12.00	4.51	301	35	11.63	4.24
Total	26.12	324			2328	278		
Mean	373	46	12.35	4.44	334	40	11.90	4.59

APPENDIX B

DATA COLLECTING FORMS

Form 1

RANDOMLY SELECTED OBSERVATION POSITION-TIME PERIODS

Date:_____

No.	Random No.	Area	Time	No.	Random No.	Area	Time
1				45			
2				46			
3				47			
4				48			
5				49			
6				50			
7				51			
8				52			
9				53			
10				54			
11				55			
12				56			
13				57			
14				58			
15				59			
16				60			
17				61			
18				62			
19				63			
20				64			
21				65			
22				66			
23				67			
24				68			
25				69			
26				70			
27				71			
28				72			
29				73			
30				74			
31				75			
32				76			
33				77			
34				78			
35				79			
36				80			
37				81			
38				82			
39				83			
40				84			
41				85			
42				86			
43				87			
44				88			

Form 2

MATRIX: WORK AREAS AND QUARTER-HOUR TIME INTERVALS

Date_____

Time Intervals	Work Areas 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
6:30 - 6:44																
6:45 - 6:59																
7:00 - 7:14																
7:15 - 7:29																
7:30 - 7:44																
7:45 - 7:59																
8:00 - 8:14																
8:15 - 8:29																
11:30 -11:44																
11:45 -11:59																
12:00 -12:14																
12:15 -12:29																
12:30 -12:44																
12:45 -12:59																
1:00 - 1:14																
1:15 - 1:29																
1:30 - 1:44																
4:30 - 4:44																
4:45 - 4:59																
5:00 - 5:14																
5:15 - 5:29																
5:30 - 5:44																
5:45 - 5:59																
6:00 - 6:14																
6:15 - 6:29																
6:30 - 6:44																

Form 3

OBSERVATION TIMES ARRANGED IN SEQUENTIAL ORDER - A.M.

Date_____

Minutes	5:00AM 5:59AM	6:00AM 6:59AM	7:00AM 7:59AM	8:00AM 8:59AM	9:00AM 9:59AM	10:00AM 10:59AM	11:00AM 11:59AM
00 - 01							
02 - 03							
04 - 05							
06 - 07							
08 - 09							
10 - 11							
12 - 13							
14 - 15							
16 - 17							
18 - 19							
20 - 21							
22 - 23							
24 - 25							
26 - 27							
28 - 29							
30 - 31							
32 - 33							
34 - 35							
36 - 37							
38 - 39							
40 - 41							
42 - 43							
44 - 45							
46 - 47							
48 - 49							
50 - 51							
52 - 53							
54 - 55							
56 - 57							
58 - 59							

Form 4

OBSERVATION TIMES ARRANGED IN SEQUENTIAL ORDER - P.M.

Date_____

Minutes	12:00PM 12:59PM	1:00PM 1:59PM	2:00PM 2:59PM	3:00PM 3:59PM	4:00PM 4:59PM	5:00PM 5:59PM	6:00PM 6:59PM	7:00PM 7:59PM
00 - 01								
02 - 03								
04 - 05								
06 - 07								
08 - 09								
10 - 11								
12 - 13								
14 - 15								
16 - 17								
18 - 19								
20 - 21								
22 - 23								
24 - 25								
26 - 27								
28 - 29								
30 - 31								
32 - 33								
34 - 35								
36 - 37								
38 - 39								
40 - 41								
42 - 43								
44 - 45								
46 - 47								
48 - 49								
50 - 51								
52 - 53								
54 - 55								
56 - 57								
58 - 59								

Form 5

DAILY OBSERVATION SHEET

Date________________ Hospital________________ Observer________________

Obs. No.	Pos. No.	Time	Work Function No.	Obs. No.	Pos. No.	Time	Work Function No.

Form 6

TALLY SHEET FOR WORK SAMPLING OBSERVATIONS

Position_____ Hospital_____
Recorder_____ Date _____

WORK FUNCTION NUMBER	NUMBER OF TIMES ACTIVITY RECORDED						
	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
1. (A)							
(AA)							
(B)							
(BB)							
(C)							
(CC)							
(D)							
(E)							
(F)							
(G)							
(H)							
(I)							
(J)							
(K)							
(L)							
(M)							
(N)							
(O)							
(P)							
(Q)							
(R)							
(S)							
(T)							
(U)							
(V)							
(W)							
(Y)							
(Z)							
2. (A)							
(B)							
(C)							
(D)							
(E)							
(F)							
(G)							
(H)							
(I)							
(J)							
(K)							
(L)							

Tally Sheet for Work Sampling Observations - continued

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
3. (A)							
(B)							
(C)							
(D)							
4. (A)							
(B)							
(C)							
(D)							
(E)							
(F)							
5. (A)							
(B)							
(C)							
(D)							
(E)							
(F)							
(G)							
6. (A)							
(B)							
(C)							
(D)							
7. (A)							
(B)							
(C)							
8. (A)							
(B)							
(C)							
(D)							
9. (A)							
(B)							
(C)							

Form 7

DAILY TRAY COUNT BY MEAL

Day_____
Date_____ Observer_____

KIND OF TRAY	TALLEY OF TRAYS	TOTALS	
BREAKFAST			
General, Soft			
Liquid			
Modified			
DINNER			
General, Soft			
Liquid			
Modified			
SUPPER			
General, Soft			
Liquid			
Modified			

LOMA LINDA UNIVERSITY

Graduate School

ACTIVITY ANALYSIS OF PERSONNEL ON PATIENT TRAYLINE ASSEMBLY

by

June Bishop

An Abstract of a Thesis

in Partial Fulfillment of the Requirements

for the Degree Master of Science

in the Field of Food Administration

January 1971

ABSTRACT

ACTIVITY ANALYSIS OF PERSONNEL ON PATIENT TRAYLINE ASSEMBLY

The systems approach in food service administration is the initial step in analyzing current procedures to determine the effectiveness of resource utilization. Analysis begins with observation of a system to provide possible explanations of the system behavior.

The purpose of this research was to determine through work sampling the proportion of both productive and nonproductive labor time of operators on the tray assembly, the labor time and labor cost required in each position and for each meal, and to test the hypothesis that there was no significant difference between the productivity index (trays per minute) during Phase A and Phase B. The dietary service of a 408-bed hospital provided the basis for this study.

Input data for the computer generated (1) the proportion of time each operator was observed in each work function activity, (2) and the amount of labor time and labor cost expended in each position and for each total meal assembly.

Following Phase A three changes were made in trayline operation to test the effect on the productivity index.

Findings from statistical analysis showed that there were significant decreases, at the 0.05 level, in labor time and labor cost in some positions and for some meals. There was no descernable pattern evident

for decreases in labor time and labor cost which could be supported by the data. No significant improvement in the productivity index during Phase B was indicated. One reason for this may have been the increased proportion of modified diet trays during Phase B. Findings showed a large expenditure of time and labor cost for the supervisory and inspection positions due to the skilled and high-salaried operators in these positions. Behavioral patterns observed as problems were (1) frequent conveyor belt stops due to missed or incorrect items on trays, (2) the large number of diverted and corrected trays, (3) lack of supplies at some positions at the time needed, and (4) extra and higher labor cost personnel in the inspection and supervisory positions.

Recommendations suggested from this research were (1) continuation of work measurement studies to provide data for developing time and workload distribution standards for each position, (2) to determine the optimal labor needs for the supervisory and inspection positions and the most effective way to accomplish these functions, (3) to study the effects of the number of modified diet trays on the productivity index, and (4) to implement and evaluate an employee training program.

This study has made a contribution to food systems management by providing quantitative data which can be used, with additional data, to establish normal service time and workload distributions for each position of tray assembly.